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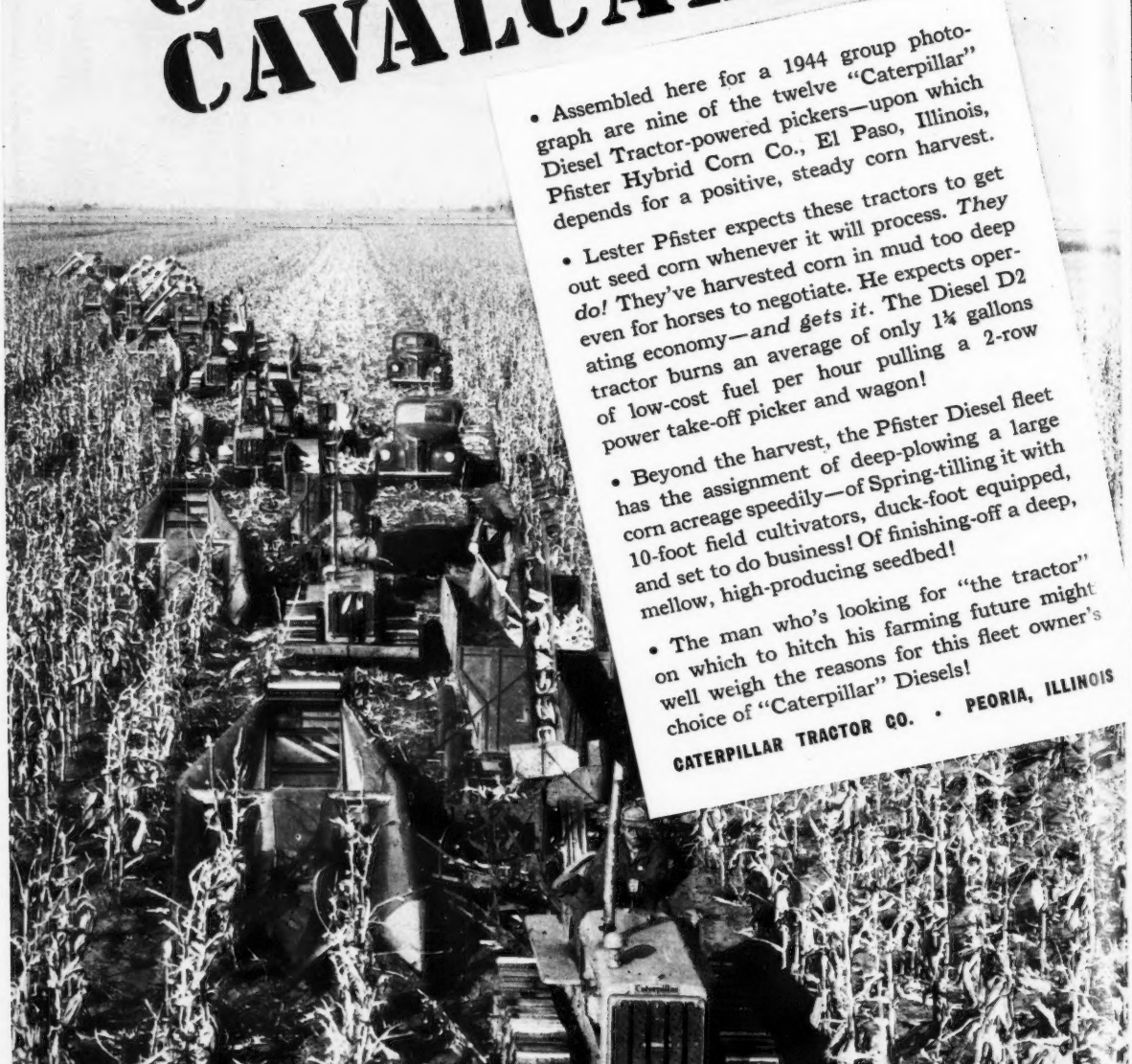
CORNFIELD CAVALCADE!



• Assembled here for a 1944 group photograph are nine of the twelve "Caterpillar" Diesel Tractor-powered pickers—upon which Pfister Hybrid Corn Co., El Paso, Illinois, depends for a positive, steady corn harvest.

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EDITORIAL

Net Cannot Exceed Gross

"LOST savings, wrecked homes, years of wasted effort and waste of public funds will result from the crop of new farmers after the war. For every successful farmer out of the servicemen and city workers who will have a try at farming, there will be many failures. . . . Failure does not necessarily mean bankruptcy. It is all evidenced by the rural slums, illiterate, undernourished, and meager existence of thousands of farm families in this rich . . . nation."

In this forthright fashion begins a special message, for information of servicemen and city workers, sent to subscribers of the "agricultural digest" issued by the Doane Agricultural Service headed by D. Howard Doane, well known to members of the American Society of Agricultural Engineers as a frequent participant in its technical meetings and an effective cooperator in its activities. Compressed into a single typewritten sheet, this special message is the most complete and realistic analysis, and the soundest counsel, that we have seen on the outlook for prospective farmers.

It is of particular interest to agricultural engineers because it points out with cold figures and brutal candor the utter futility of trying to eke out an existence on a farm of insufficient size and productivity. It does not go into detail, but to us the reasons are obvious. No amount of mechanization, any more than unlimited drudgery by hand methods, can push production above the ceilings set by soil, sun and moisture. Likewise no degree of thrift and efficiency can achieve a decent net income where the gross production is itself inadequate.

On our profession lies the duty to proclaim the fact that the abundant life in agriculture can come only by increased production per man. It may well mean fewer people in farming, not more. Certainly the subdivision of acreages already too small is not the solution of the postwar unemployment problem, or any other problem.

Dignify the Hired Man

IN THE Doane "special message," mentioned in the foregoing editorial, much emphasis is placed on practical farm experience as a prerequisite to successful operation of a farm, large or small. Employment as a farm laborer is suggested as a way to get such experience. We would go further and say it is *the* way.

In a truly engineered agriculture there should be new dignity and new reward for the hired man. Whether owner or employe, the man who turns three furrows can and should earn more than the man who turns but one. The man, hired or proprietor, who operates a pickup baler or corn picker can and should be more richly rewarded than one who wields a pitchfork or husking peg. The true promise of engineered agriculture includes employment as such, not as proprietary peasants.

Aside from adequate pay, the hired man of tomorrow will have the satisfaction of working with machinery that makes him the master of power, not its source. He can fairly expect that his home will have the same piping and wiring, the appliances and advantages that prevail in the homes of urban employes. His family should enjoy the same advantages as if they lived in a city.

To bring about these conditions will involve added work for agricultural engineers in structures, electrification and machinery. We believe it is an assignment they will enjoy.

Engineers Must Teach

IT IS clearly incumbent on us to realize the interaction between our life task and world problems in general. A broader understanding of sociological problems has become essential for the engineer. His work no longer embraces only the use of materials and sources of energy; he has, as well, to understand and handle human beings. The products of his technical skill affect every human individual and every human organization. On the other hand, a greater understanding of science in general and engineering in particular has become essential for every citizen. In the logical pursuit of our mission to help the postwar world, we must therefore teach the principles which underlie our work, in the hope that they may be accepted and applied.

What exactly have we to teach? The first lesson arises from our training. We begin by trying to discover the fundamental facts before we draw any conclusions, or make a plan, or try to erect a building, or to construct a machine. Guided by experience and observation, we establish and test these facts; we do not start with assumptions or build on imaginary foundations. We test the facts under varying conditions, their uniformity, their variety; we establish their limitations; we draw conclusions, and apply them in successive steps, always taking into consideration the means at our disposal and shunning universal application where variables apply. Having established and correlated our facts, we formulate what we term laws. Applying these laws, we tap new sources of energy, construct new machinery and devices, produce new materials. Fortified by experience we venture into the unknown, realizing that cause and effect are inextricably interwoven, that every potential produces a stress, that every action produces some positive or negative result.

Throughout, our mental attitude should be that of a seeker for truth. Integrity of purpose, disciplined imagination, and power of critical analysis form the essential basis. Access to the factual material available, together with knowledge of the scientific techniques at our disposal are, of course, indispensable. These alone can give that competence and confidence required to formulate any sound policy, or to come to any clear cut decision; they alone can constitute what we term "scientific approach." This same approach, this same dispassionately scientific outlook, must be applied to life, to all its problems, to economics and politics. Its full meaning and value must be understood not only by a restricted guild, but by humanity at large.

The second lesson which we as engineers must teach is that we do not believe in a dogmatic approach to life, in generalizations, in labels. The half-educated invariably tend to oversimplify. They do so through overconfidence in their small knowledge; they do not realize their own, or indeed any human, limitations; they are mesmerized by generalizations, which do infinite harm by insistence on partial truths; they lack a sense of proportion. We engineers are aware of our own limitations. We are always prepared to change or modify our views in the light of added knowledge. The farther we travel, the more conscious we become of the fallibility of our perceptions, the more we realize that we are finite and not infinite, and that however objective we try to be in our judgment, our objectiveness cannot be absolute; and from that knowledge should spring humility and tolerance for the opinion of others.

(EDITOR'S NOTE: The foregoing is quoted from the presidential address of Sir Harry Railing to the Institution of Electrical Engineers in London, October, 1944.)

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AGRICULTURAL ENGINEERING

VOL. 25 DECEMBER 1944 NO. 12

Fire Fighting Methods and Equipment for Rural Communities

By H. G. Ingerson

MEMBER A.S.A.E.

ACCORDING to the Extension Service of the U. S. Department of Agriculture, there are 3,500 lives lost in farm and rural non-farm fires each year and the rural property loss is $225,000,000 or 65 per cent of our national fire loss.

Rural communities can soon have very complete fire protection by using methods and equipment perfected during the war. In discussing this subject I will relate the development of the method and equipment, explain the principles involved, and suggest a way in which agricultural engineers can render an entirely new and very valuable service to the rural communities in every state.

To show the need for better methods of fire control I shall describe just two rural fires in which I had personal experience. The first was a fire which threatened over $50,000 worth of new farm buildings and equipment. A large orchardist in northern Ohio, near Cleveland, had built a group of three buildings, two large fruit storages and a combination fruit packing house and by-products plant. For efficiency in transferring the fruit from the storage houses to the packing room, these buildings were grouped closely together. They were of frame construction with stucco exteriors, but unfortunately the stucco had not been completed on the central building. The packing room was between the two storages. A refrigeration compressor was located in the service room at one end of one of the storage houses. It was expected that electric power would be available to operate the compressor, but the power line was delayed and a tractor was being used to power the compressor. A workman disobeyed orders and filled the tractor while running. Some gasoline spilled, ignited from the tractor coils and the service room and adjacent sides of the packing house were in flames almost instantly. This farm was five miles from the nearest town and the only fire equipment there was a "pumper" which could work only from a city water supply. Fortunately the owner had equipped his modern packing house with two chemical extinguishers. These together with a fortunate turn of the wind allowed the workmen to bring the fire under control. Fire equipment such as we will describe would have been ideal for this condition.

The other fire was in a farm home. Riding with a friend a few miles out of Port Washington, Wisconsin, we saw a frame summer kitchen on the rear of a substantial brick farmhouse all in flames. There was no one around the fire, and it appeared that the owners might be away. We drove into the yard, went to the house, and the owner's wife came to the door. Yes, she knew of the fire, had telephoned to the nearest town for fire equipment, and had sent her son to the back of the farm to call his father. My friend inquired what fire department had been called, and as several neighbors were in sight, he went to see if he could hurry up the fire department. When he reached the fire station, about three miles distant, the truck driver was having trouble starting the ancient Model T fire truck. Finally it got underway, and was about half way to the fire when it stopped for want of gasoline. My friend had a tow rope and towed the fire truck to the fire. Again this truck had only a "pumper", and the only source of water was a cistern at the barn, too far away for the hose lines to reach the fire. By this time the fire had quite burned itself out, and by virtue of the house being brick and the neighbors and myself carrying many pails of water from the cistern to the upstairs of the house where we could fight back the small fire that ran in around a window, the house was saved.

These are just two instances of farm fires at which I have been present, but in neither case was adequate equipment or a trained rural fire fighting crew available, and more by good fortune than good management were the buildings saved.

By contrast, and to show what can be done with suitable equipment: Another rural fire was brought under control in less than 4 min by high-pressure fog (600 lb per sq in at the gun or nozzle) with an amount of water that can be hauled by any good 1½-ton truck. The building was an abandoned hunting lodge approximately 50x30 ft in ground dimensions, one story high and built of tamarack logs. It was extremely dry. It had not been used for several years and was a fire hazard in case careless campers or hunters should use it. Permission was secured to use it for a test of the high-pressure fog fire fighting method. Some inflammable material was placed in one corner of the building and a match touched to it. Within two minutes of the start of the fire the entire building was in flames. It had been agreed between the county agricultural agent who made the arrangements for this fire test and the firemen that they would try to cut the fire off at a partition, about one-third of the length of the building. Two firemen worked on this fire each with a high-pressure fog fire gun discharging 30 gallons per minute

Paper presented before the annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis., June, 1944. A joint contribution of the Power and Machinery and the Farm Structures Divisions.

H. G. INGERSON is sales manager, John Bean Mfg. Co.

(Left) Firemen fighting a farmhouse fire with high-pressure fog, using equipment like that shown in the picture at the right. (Right) A John Bean high-pressure fog fire fighting unit suitable for fighting farm and other rural fires

when wide open. The total time elapsed from the time the firemen started work until the fire was under control was just under four minutes; the fire was out in six minutes, and the total water used was just under 350 gal. As a result of this and similar tests, there are now several high-pressure fog fire fighters owned by the townships in Oscoda County, Michigan, making real fire protection available in a sparsely settled rural community where farm fires and forest fires had long been a dread.

Now what are the principles involved in this high-pressure fog fire fighting method? Several fundamental principles are working together, including very rapid (almost instantaneous) conversion of the very fine water particles (fog) into steam. This action absorbs a tremendous amount of heat and quickly lowers the temperature of the burning material until it is below the burning point. The steam in turn smothers or "blankets" the fire by displacing the air, that is, shutting off the oxygen needed for combustion. The whole action is so fast that it is hard to believe what one is actually seeing.

This method has been used successfully on hundreds of structural fires in the past few years. It has also been used extensively and successfully for controlling airplane crash fires to effect the rescue of the pilot and his crew, and it is being used in industrial fires where highly inflammable materials are involved and where chemicals or other means of fire control are not suited. It is being used by city fire departments as an auxiliary to other methods and other types of equipment.

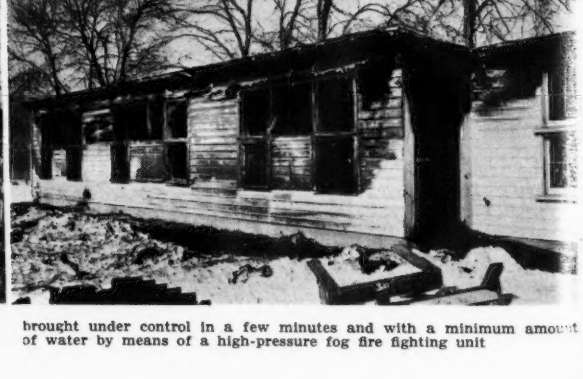
The equipment we recommend for rural fire protection consists essentially of a 60-gpm (gallon per minute) displacement type pump suited to continuous operation at pressures of 800 psi (pounds per square inch). This allows for pressure at the gun of 600 psi even with long leads of hose. The pump is operated through the split-shaft type of power take-off unit from any of the lighter models of motor trucks such as International, Ford, Chevrolet and others of that size. A tank holding approximately 400 gal of water is mounted compactly in the unit, the entire mounting being as low as possible for stability and suiting the equipment to traveling the highways at high speed. An important consideration is the protection of the pump and piping against freezing, and this is accomplished by taking advantage of heat from the truck motor exhaust. The discharge of water is carried to two lines of high-pressure, ¾-in rubber hose. These lines of hose are compactly mounted on live type hose reels and, except during severely cold weather, pressure is carried in the hose and guns at all times. Suitable connection is provided in the suction piping for connection to a fire hydrant, if such is available; this same connection is used for taking water from any type of water storage where this is available.

Two very important parts of the equipment are the specially designed high-pressure fire guns. These are designed so that one fireman can handle a line of hose and the gun by himself, and the gun is quickly and easily adjustable from the long solid type of stream to a close-up, fine water fog. The total weight of the equipment above the truck chassis is approximately one ton, and when the tank is filled with water, the gross weight is approximately 2½ tons. The conventional 1½-ton truck carries this load readily as the entire unit is compact and the load well distributed. The important accessories are floodlights, ladders, axes, pike poles, wire cutters and other small hand tools. Space is provided so that six fireman can ride comfortably, but there would rarely be more than two on the equipment as it goes to rural fires.

This high-pressure fog method is especially suited to rural fire control for several reasons: (1) Most rural fires are building or structural fires which are easily controlled with water. (2) Most farm fires are discovered soon after they start. (3) The call can be made to the fire department, and the fire brought under control after the equipment makes the run. (4) The fire-fighting equipment has the water right with it, and this water can be doing effective work on the fire within seconds after the equipment arrives. (5) The water and pressure is in the hose and gun, and no time is lost putting a suction hose in a cistern or pond, if there is such a thing nearby. There is no waiting for valuable minutes to get "pressure up" as the firemen can get the high-pressure fog *on the fire* almost instantly. (6) A small fire crew only is needed. The truck driver operates the pump, regulates the pressure, makes the accessory equipment of ladders, axes, lights, etc., available while the farm owner and trained neighbors handle the fire guns. I emphasize the word "trained", because the success of any rural fire control program depends on trained *local* people. (7) This type of high-pressure fire fighting equipment is suited to rural communities because of its very high over-all efficiency in fire control with very nominal first cost and low maintenance. The high-pressure hose lasts several years in fire service and there is very little other upkeep cost. (8) These fire fighters can be mounted on makes of 1½-ton trucks on which service is available in nearly all communities. (9) Very little water damage occurs to homes and furnishings in case of farmhouse fires, or to grain, hay and machinery in case of farm building fires. The protection of the water fog will usually permit the removal of livestock in case of a bad barn fire.

Now we come to the very important place where we believe college agricultural engineers can render a vital rural service. Rural communities — villages, townships, counties — have long *needed* and *wanted* better fire protection. Matters of legislation and taxation are involved in providing financing for the purchase of equipment, in paying truck drivers, in providing suitable garages for the equipment, suitable fire-call systems and other items that enter into an adequate fire control system. Next help is needed in organizing communities properly in relation to roads, some on county lines and some on township lines, and tieing these rural communities into the municipal fire control areas.

These are but a few of the services that farm communities are going to expect from agricultural engineering departments of their colleges. Others will be the supervising and training of leaders in fire control methods. This will include county agents, assistant county agents, vocational-agriculture teachers, and F.F.A. leaders. These leaders will in turn train local rural people—men, boys, women and girls—in their duties at a fire at their farm or a neighbor's farm. Supplementary water supplies will be desirable; suitable sources of water along the highways should be located and marked, and each fire crew should know which source is closest to each farm. Auxiliary water supply trucks should be available, such as milk trucks. Each farm should work toward having some additional water available and accessible. Agricultural engi- *(Continued on page 466)*



These two views give some idea of the size and intensity of the fires that raged in these two buildings. In each case, however, the fire was brought under control in a few minutes and with a minimum amount of water by means of a high-pressure fog fire fighting unit

The Kent County System of Rural Fire Protection

By Richard Machiele

KENT County, Michigan, has used high-pressure fog fire fighting equipment for the past nineteen months and we feel it is the only type available that is well designed to fight rural fires.

The 1941 Michigan legislature made it possible to institute a fire fighting program in our county. An emergency act was passed which enabled counties or townships to organize fire protection units, the cost of which could be placed on the tax roll. This act stated that only areas having inadequate protection could come in under the new law.

After the law was enacted the Kent County board of supervisors immediately appointed a county fire committee of three members, which requested the county agricultural agent to make a survey of the existing fire fighting apparatus in the county. The results of the survey showed less than half the county having fire protection, though all villages and towns had some fire equipment of their own. This left fifteen townships to be organized under the new county setup. An agreement was made with the county road commission to house and service the equipment at county garages. Subsequently five fire districts were set up.

The board of supervisors appropriated $25,000 for the cost of equipment and maintenance for one year. Of these costs, 50 per cent was to be paid by the county and 50 per cent by townships receiving protection, each township entering into contract with the county for the payment of the money. Five Bean high-pressure fog fire fighting units were purchased, the last five units available for allotment for civilian use.

In the handling of our equipment, we feel that we have a unique feature in that there is a driver at each of the trucks 24 hours each day, every day in the year. The county road commission personnel drives the truck all week days from 8:00 a.m. to 12:00 p.m. For the other 8 hours, plus Sundays and holidays, the county has hired a driver. It is the duty of this driver to drive the truck to the fire at call and to keep the truck and fire equipment in operation. The fire fighting is done by a group of volunteer fire fighters. At the present time we have 1324 of these men.

The job of organizing the volunteers was done by the agricultural extension service, and they were organized on a township basis. We appointed a fire chief in each township who was either the supervisor or one of the members of the civilian defense setup. It was the duty of this fire chief to organize his township, to appoint township personnel and to act as a go-between between his township and the fire prevention committee. Each township was then divided into fire districts, the number of which was determined by the township fire chief. Natural boundaries and population were taken into consideration in making these divisions. In each district a fire chief was appointed and one or two alternate chiefs. It is the duty of this district fire chief to supervise the department in his territory and to appoint firemen under him. The number of firemen in each of the districts varies from 4 to 16 men, all protected under a blanket insurance.

In addition the district fire chiefs have been urged to make a complete survey of each farm in their districts and check the number and length of ladders, location of supplementary water supply, type of water systems, location and number of water buckets, ropes, axes, etc., and the number of inhabitants in each home.

Two townships have reported the survey completed and show an excellent job. Algoma Township has worked its out on a card catalog basis, while Cascade Township has its on a survey sheet. We feel this latter type of survey is valuable for volunteer fire fighters, not that the compiled survey will be put to work in case of a fire but that the volunteers have checked the essential fire fighting materials.

Ada Township has only one set of firemen for the entire township who answer all calls in that township and are paid on an hourly basis by the township board. The location of the truck makes this possible in that township, but this system would be impractical in the other areas.

Grand Rapids Township, which is mostly suburban and has very few men at home during the daytime, hires an additional man to go with the truck for all day runs.

The alarm system is entirely by telephone. Some townships are now trying to purchase large sirens, but the telephone has caused no delay up to the present time. Each home in the fifteen townships has a card which gives directions in case of fire. First, the garage which housed the equipment for that area is called. Directions are given to the driver who starts out immediately. One garage at present has override equipment on its telephone system by which any call can be interrupted by the Grand Rapids operator. Due to the emergency the telephone company has no more such equipment available at present. The next call is to the district fire chief or one of his alternates. The person reporting the fire now has done all asked of him and he has been urged not to do any more calling. As soon as the district chief gets the call he starts for the scene of the fire. Someone at his house calls four firemen, the service companies and sheriff's department. As soon as each fireman receives the call, he starts out and someone at his home calls the remainder of the firemen. The township chief's first job at the fire is to appoint traffic directors. We found this necessary after our first two fires because both the road and driveways were blocked with spectators' cars.

After each fire the truck driver and the owner of the building fill out a report form, a copy of which is sent to each member of the fire prevention committee. This report gives the approximate fire loss and saving and also shows whether the volunteers are working satisfactorily.

After the fire trucks arrived in the county an equipment demonstration was held in each township. At some of the demonstrations a company representative discussed the equipment and demonstrated its use. At most of the demonstrations the firemen had erected some sort of structure on which to demonstrate. All firemen — in fact, all those in attendance — were urged to handle the equipment. All our demonstration fires were put out in a few minutes time.

Many townships have had regular training meetings for their firemen.

The following is a summary of the types of fires and number of runs for a period of 19 months between November 7, 1942, to June 7, 1944: Dwellings, 78; grass fires, 58; farm buildings, 38; buildings other than farm, 15; autos and trucks, 12; false alarms, 2; miscellaneous, 7 — total runs, 210.

Each of our five high-pressure fog fire fighting trucks are equipped as follows: Discharge hose, 350 ft; suction hose, 30 ft; canvas hose, 500 ft for truck serving Grand Rapids; firemen's axes, 2; shovels, 2; wrecking bar, 1; pike pole, 1; raincoats, hats, hip boots, 6 sets; smoke mask, 1; waterproof lantern, 1; buckets, 12; rope, 50 ft; battery charger, 1; collapsible ladder, 1 (12 ft); extension ladder, 1 (20 ft); roof ladder, 1 (10 ft); spotlights, 2 rear and 1 front.

Kent County volunteer firemen are completely sold on their high-pressure fog fire fighting equipment for three reasons:

1 It is more effective than ordinary capacity type equipment.

2 It uses water more efficiently which is of great importance in rural fire fighting.

3 There is very little water damage after high-pressure service.

The equipment effectiveness and water efficiency was shown in a school house fire to which a capacity pumper was called. The pumper, after an hour's work decided to give it up as a loss. The Kent County truck had in the meantime been called and put the fire out using only 800 gal of water.

Water damage is slight as already mentioned. I witnessed one attic fire this past year. The fire had a good start, in fact, the entire roof was ablaze. The excess water from this fire was caught in an ordinary wash basin.

If Kent County buys new fire fighting equipment, I am sure it would again buy the high-pressure fog type.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis., June, 1944. A joint contribution of the Power and Machinery and the Farm Structures Divisions.

RICHARD MACHIELE is assistant county agricultural agent, Kent County, Michigan.

The Problem of Securing Machinery for Farm Reservoir Construction

By John L. McKitrick
MEMBER A.S.A.E.

ONE OF the chief handicaps to dairying and livestock production for many years has been the lack of adequate sources of water throughout the year. Because of limestone formations in most parts of Kentucky, the drilling of deep wells is a gamble which most farmers do not wish to take. On most farms in central Kentucky at least one and in some cases five or six deep wells have been drilled without success. Shallow wells, springs and cisterns fail to supply water during droughts even of a few weeks' duration. Large ponds or farm reservoirs have proven to be the most satisfactory source of water for livestock.

Prior to the war period, agricultural engineers and county agents, cooperating in an educational program with farmers and operators of heavy earth-moving equipment, brought about an increase in annual construction of farm reservoirs from 244 in 1938 to 4466 in 1941. Due to the shortage of track-type tractors, bulldozers and scrapers, caused by construction work on war projects and scarcity of repairs and labor, this figure was reduced to 2346 in 1942 and in 1943 a total of 3309 ponds and reservoirs were reported by county agents. Many of them are small ponds, sometimes called "sky ponds", excavated without supervision, with farm equipment, near the tops of slopes, and with little or no drainage area above them. They are practically filled by direct rainfall and soil water during wet seasons. However, because of limited storage capacity and drainage area, these ponds are usually dry during periods of drought when water is most needed; or the small amount of water they hold becomes unfit for livestock. In some instances, farm tractors and small scrapers have been used for constructing reservoirs, but as a rule scarcity of farm labor and the requirements of tractors for field work when weather is suitable for work of any kind prevents construction of farm reservoirs with farm equipment.

Then, too, earth moving is heavy work. The earth moved in the construction of farm reservoirs is substrata which is not ordinarily handled with farm equipment. It is a highly mechanized job, involving several hundred cubic yards of material. The job requires equipment that can move earth efficiently and quickly in fairly close quarters.

An extended period of drought over much of Kentucky in 1943 and an increase in the number of livestock on farms have created a scarcity of water on farms throughout the state, for which there is apparently no remedy unless power equipment can be made available to farmers through custom operators. A survey in 58 Kentucky counties showed that 9450 farmers moved livestock or drove herds to water in 1943 and that 12,869 hauled water an average distance of 4 miles. The water-shortage period was from August 1 to November in the majority of counties. The scarcity of tires, gasoline and trucks has handicapped the trucking of water from available sources. As a result, considerable livestock not ready for market had to be sold. In recent years, a drought has occurred in some part of the state almost every year. The lack of a good water supply has become an important limiting factor in profitable production of livestock on many farms in Kentucky.

During 1943, in all counties, the desire of farmers to construct farm reservoirs could not be satisfied with available equipment. Priorities were granted for the purchase of five track-type tractors and bulldozers to be used in building earth dams. We could use that many per county in areas where the water supply is most critical. I feel safe in saying that at least 300 more track-type tractors, not less than 40 hp, with earth-moving equipment, could have been used in Kentucky this year. We are told that the allotment for Kentucky is one unit every fifteen months.

We have had considerable experience in all sections of Kentucky, as well as some experience in other states in the Ohio and Tennessee River Valley, working with cooperative associations and custom operators operating power equipment to construct terraces, farm reservoirs, clear land, drain land, grade roads, and do other jobs the farmer is not equipped to do in the most economical way.

We have used everything from rotary scrapers on up to try to get the job done. We have definite ideas as to what unit is the most economical one to use, but when farmers are forced to sell dairy herds and other livestock because of lack of water, we will use anything we can, nor are we particular whether the units are cooperative or individually owned.

The general trend in Kentucky has been towards a decrease in the number of cooperative associations throughout the state and a decided increase in the number of custom operators. We have observed, too, that the cooperative association, to be successful in all phases of its work, requires a considerable amount of personal attention from some state or government agency. We cannot render that service except to a limited number of counties in Kentucky, and in those counties the operation of power equipment by associations has declined rather than increased.

Some of the advantages and disadvantages of the two methods of rendering service aside from supervision of associations, as experienced in Kentucky, are as follows:

1 Cooperative associations are able in most instances to operate at a slightly lower hourly charge.

2 Where technical supervision of operators is available, the work done by an association is of higher quality than that done by the average private operator.

3 No direct control concerning quality of work done can be exercised over a private operator, except by the landowner who must be taught what to require of the operator. Specifications for farm reservoirs and other production practices, required by the AAA as a prerequisite of payment, will greatly improve the character of work demanded by farm owners in Kentucky.

4 The greater initiative of private operators frequently offsets the lower hourly charge that a non-profit cooperative association can make, resulting in equal costs to farmers.

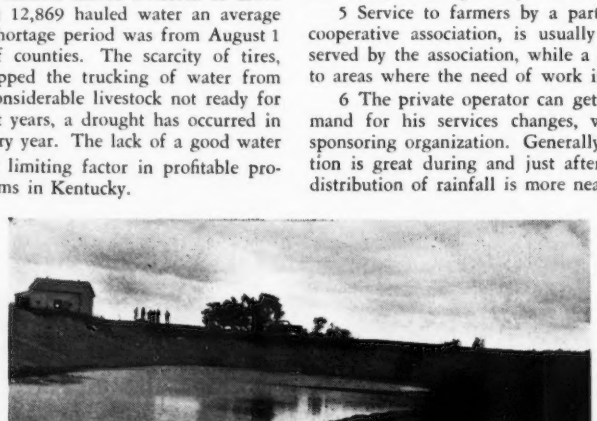
5 Service to farmers by a particular machine, controlled by a cooperative association, is usually limited to the area or county served by the association, while a private operator is free to move to areas where the need of work is most acute.

6 The private operator can get in or out of business as the demand for his services changes, without affecting in any way a sponsoring organization. Generally, demand for reservoir construction is great during and just after a drought, and is slight when distribution of rainfall is more nearly normal. This discontinuance of service rendered by a sponsored cooperative association usually is interpreted as a failure for which the sponsoring organization is responsible.

7 Cooperative associations seem to have had as much or more difficulty in obtaining new machines and repairs during the past year as have private owners sponsored by some county agricultural organization.

Counties in which soil conservation districts have been organized have been looking forward to the time

(Continued on page 462)



A new farm pond partially filled with water

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis., June, 1944, as a contribution of the Soil and Water Division.

JOHN L. MCKITRICK is extension agricultural engineer, University of Kentucky.

Applications of New Developments in Timber Construction to Farm Buildings

By L. P. Keith

NECESSARILY wartime is a time of change, and so we are going through a period of development in all things. Some advances are the fruition of ideas born long ago; others come from war needs, and the war accelerated the advancement.

Now there is an airport within a few hours of every farm, and every airport is within sixty hours by air of any place on the globe. Chemicals and plastics with unfathomed possibilities are being born at a rate which appears to exceed that well-known, one-a-minute birth rate. Structural features of houses are changing, although hardly keeping pace with the dreamers. Mechanical equipment thought modern for housing a short time ago is obsolete for housing today — if we could build houses today. The use of fractional horsepower motors, restricted now, will affect modes of living as soon as peacetime becomes effective.

Agriculture has been experiencing, and will continue to participate in, changes. The mechanization of the wheat crop has resulted in the replacement of the two-story horse barn with an all-purpose barn. Developments in wood construction have made possible a simple structure of this type which, because of its barrel roof, offers very little resistance to wind — streamlined in accordance with the true meaning of the word instead of the much pirated use to describe any product of changed outline even though never exposed to the breeze of an electric fan. The inside of this all-purpose barn is free of posts and may have a clear span of fifty feet or even more. It can serve as a bunkhouse for planting or harvesting crews, for storing machinery, and for storage of the wheat crop. Many regard it as more efficient than any other type of structure for its purpose.

Similarly, the mechanization of corn production has changed granary design. The result is a lower structure of greater storage capacity built with less material.

I understand the hay crop is the last of the three major crops to be mechanized. What will it mean to buildings in a dairy community? Pitching hay is backbreaking; mechanization will alleviate this. The effects of weather will be minimized. If the pickup baler becomes the best way to harvest hay, are you going to continue to hoist hay into the mow? Are present haymows structurally strong enough to support more concentrated loading? If grass silage proves to be the answer to the haying problem, what will be put in the mow? What about chopped hay? Will separate structures be used, or will the present mows be adequate? Will it be necessary to develop new designs if mow curing becomes feasible?

The lumber industry is working out and testing designs to take full advantage of these developments. None of us can be sure just how things will be done 15 years from now. Farmers are smart if they guess a year ahead in crop and livestock programs. There is one thing we can do, and that is to watch developments and adopt them when they have proved of value.

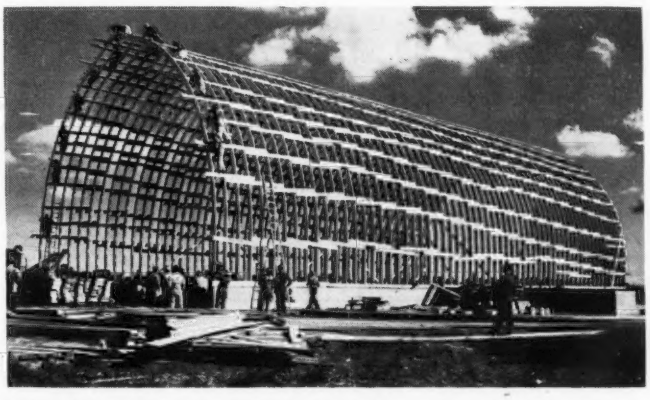
To meet the requirements as they may change from time to time the lumber industry has available several relatively new systems of wood construction, new forms of forest products, and new fastenings, all of which will help to make better, more economical farm buildings. These developments in the art of using wood structurally were initiated in the prewar period, because it was recognized that joints in trusses and fastenings were the weakest parts of wood construction. Markwardt of the USDA Forest Products Laboratory has aptly characterized these weaknesses as the Achilles heel of wood construction. Research sought correction, and there resulted two new systems of wood construction — laminated construction and Teco modern timber connector construction. Both were proven methods before the war, and both developed stupendously in war construction.

The most striking example of the use of both systems in the same structure is the Chicago aircraft assembly plant, which has connectored 150-ft wood trusses supported on glued laminated wood columns. This is significant because the plant is the largest timber factory in the world. Areas free of posts are 75 by 150 ft. Some of the glued columns are 56 ft long and 17½ by 34½ in in cross section, built up by gluing together one-inch boards of random widths, 4 in and wider, to form a stick free from seasoning defects and of a size unobtainable in wartime. Or, if this example does not stir your imagination, consider the Navy's gigantic blimp hangars of connectored wood construction with arches of 237-ft span soaring to 153 ft and the hangar extending 1,000 feet in length, thus covering an area equivalent to three football fields.

You ask: Are these new systems of wood construction applicable to small farm structures? Rilco has demonstrated this affirmatively, utilizing laminated wood arches for ribs and split-ring connectors for strengthening the more critical joints. The results are rigidity, light weight for portability of small structures, economy in cost, and efficient use of material. Every agricultural engineer is sufficiently acquainted with this modern type of barn to compare it with the old post-and-girt system where building was so difficult that neighbors were sometimes called on for help.

Connectors have had spectacular use in gigantic structures; they have also been used advantageously and extensively in some structures which are small and relatively unimportant. The efficiency of the connector joint and the adaptability of the connector system to prefabrication augurs increasing use in farm structures.

Plywood, first made by the Egyptians, was well established as a construction item before we entered the war, but it also has made great strides because of war requirements. Results of research for aircraft construction will not be discarded when peace comes. In war or in peace large sheets of material possessing the merits of wood, which are easily handled and which offer great rigidity, will always be in demand.



Modern barns have glued laminated-wood arched rafters with critical joints to other framing reinforced with modern timber connectors (Photo: Rilco Laminated Products, Inc.)

Then, in addition to plywood, we have the somewhat numerous insulation and building boards made from wood fibers. They are similar to plywood, sharing some of its qualities, not equaling it in some, and having superior merit in others, particularly insulation. The raw material from which they are made would ordinarily be sawmill waste. The war has brought them into even more varied and extensive use than that of the prewar period, and it is anticipated that the future will provide greater use on the farm.

All the methods and materials discussed in the

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis., June, 1944 as a contribution of the Farm Structures Division.

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foregoing lend themselves readily to prefabrication of farm structures by the local retail lumber yard. This will make for more economical construction. Prefabrication will mean, in addition, that the farmer will have either more time to devote to his many other tasks or more time for leisure. Or perhaps part of the answer will be found in the dealer's precutting to length, leaving assembly of parts for the farmer during winter months.

The art of gluing has made such strides recently that we are apt to see toenailing, the traditional — and poor — method of framing light wood structures, become obsolete. Even before these advances, a lapped joint with spikes and glue had already passed the experimental stage, as Henry Giese of Iowa State College can tell you. (Journal Paper No. J-716 of the Iowa Agricultural Experiment Station, Project 23 and 563.) It is like spot welding, and it may develop into the accepted means for the joining in the smaller structures. In fact, this general method has even been efficient in structures of engineering importance, such as rigid frames at the Great Lakes Exposition in Cleveland a few years ago where plywood was glued to timber frames, nails applying suitable pressure while the glue was setting.

So far we have only discussed methods of proven practicability for structural use. The postwar construction field will most likely see wood products used which are only in their infancy now. We feel certain there is a great future for plastics, even though we cannot now define the uses in detail. "Compreg," a coined word from compressed and impregnated, will offer a material with 80 per cent the strength of steel and only 20 per cent of its weight. Compreg has a first cousin, less known and younger, called "Papreg," made from compressed and impregnated paper.

The foregoing is but a mere outline of developments but is one which shows the great versatility of the material. Wood has become one of the engineering materials, but nevertheless it has not discarded its inherent long-known virtues. It is so easy to work that farmers have been able to use it for years without highly skilled labor and expensive equipment.

Hand in hand with versatility of the material goes versatility of supply, demonstrated by its availability as a raw product from 20,000 dealers and by the extent to which many of these dealers and some manufacturers have gone in making available, either in semifinished or completely finished form, brooder coops, feeding racks, silos, hog houses, granaries, and other similar farm structures.

Back in 1908, Gifford Pinchot, chief forester, made some very erroneous prophecies. Said Mr. Pinchot then: "We have in store timber enough for only 20 or 30 years," and " A timber famine is one of the inevitable events of our own near future." Like the very premature report of Mark Twain's death, the timber famine was greatly exaggerated, for 36 years later and six years after the deadline of the prediction, which failed to take into account new growth, we are meeting demands which call for more than half a normal year's production for use in boxes and crates alone, and, according to the office of the Secretary of War, approximately eight tons of lumber — roughly 6,000 fbm — are required to establish one American soldier on a beach head and a ton each month thereafter to keep him there. There would be more lumber for your use today, after meeting war demands, if we had the man power; the famine is in men and not in trees.

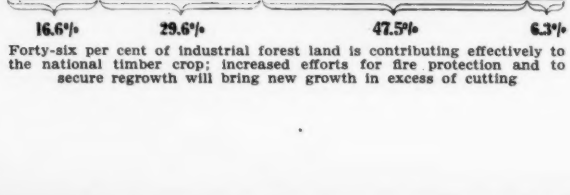
Arithmetical estimate indicates 50 years' supply of timber, although this might be reduced to forty because some is inaccessible. Offsetting an annual drain of 13 billion cubic feet, we have new growth amounting to 11 billion cubic feet, or a ratio of 1.2 to 1.0. Prophecies are difficult, but we believe the country is headed to a growth exceeding consumption and loss. Early achievement of fire protection goals, with accompanying improvement in cutting and utilization methods, promises a favorable balance in 15 to 30 years.

Thus the lumber industry is as permanent as agriculture and has both the supply of material and new methods of use to continue servicing agricultural needs.

CONDITION OF INDUSTRIAL FOREST LAND

(As Reported by State and Industry Forest Authorities to National Lumber Manufacturers Association)

COVERING 153 MILLION ACRES OF PRIVATE TIMBER LAND



Forty-six per cent of industrial forest land is contributing effectively to the national timber crop; increased efforts for fire protection and to secure regrowth will bring new growth in excess of cutting

Farm Reservoir Construction

(Continued from page 460)

when government-owned equipment will be turned over to the district for operation on a cost of operation plus replacement basis and are not much interested in sponsoring a cooperative organization to bear all of the responsibility of ownership and operation.

At present it appears to me that privately owned equipment for customs work sponsored by non-commercial agricultural improvement associations and an educational program directed to both farmers and operators by all interested agencies, are solutions to our problems of improving the livestock water situation in Kentucky.

When the war is over, we shall be in favor of encouraging cooperative associations in the Tennessee Valley program to include this service again in their soil management program. These county cooperative associations manage the activities related to the test-demonstration program in the regional development of the Tennessee Valley. They are now in the process of organizing a federated association of the county cooperatives in the Tennessee Valley counties in order to carry on the program more effectively, especially the development of cooperative projects.

It is expected that one of the services will be to provide power equipment for the services we have already mentioned. With a setup of this kind, our cooperators feel that they can overcome the disadvantages we have mentioned, especially in providing technical supervision of operators and a service truck with a good man to service the equipment. But this is postwar planning.

My sole purpose in accepting an invitation to appear on this program is (1) to acquaint you with the situation in Kentucky which is typical of that in the Tennessee Valley states and which I feel sure is typical of the situation in the sections of the country which you represent, and (2) to determine if anything can be done by the A.S.A.E. toward securing adequate equipment to provide enough water for the number of livestock needed for the wartime program.

I believe that, if tractors with earth-moving equipment were available for custom work, 20,000 small lakes or farm reservoirs would be built or rebuilt in Kentucky this year. That would mean about 200 reservoirs by each of 100 outfits. In 1941, 50 outfits built ninety each and worked only a part of the year. This year, because of the drought of 1943 and the increased number of livestock on farms, there is a much greater need and a much greater demand on the part of farmers for custom operators to build farm reservoirs, even at a higher rental rate per hour than was charged in 1941.

Here is a specific example of the importance of an adequate supply of water, as well as feed, in livestock production and dairying. Herringer Brothers, in Campbell County, have a good herd of high-producing Holsteins. Two or three years ago they built a good farm reservoir to supply water to this herd. It furnished an ample supply during last year's drought. In December 1943 they decided to install an electric pump and tank to supply water from the pond to the water bowls attached to stanchions in the barn. The total milk produced was weighed for three days before the water bowls were put into operation and for three days immediately following. The increase in milk production was 124 lb per day from 19 cows, or about 6½ lb per cow per day. The increase of 124 lb of milk per day was worth $4.65. The price of milk was $3.75 per 100 lb. Before the water bowls were installed, the herd was allowed to drink their fill twice daily directly from the pond.

We are told that agricultural engineering services are of tremendous importance in war food production, but we cannot do the job without equipment. The importance of an adequate supply of water for livestock is recognized, or the Agricultural Adjustment Agency would not have included a payment of 15c per yd of earth in place for constructing earth dams for farm reservoirs in Kentucky. Farm reservoirs cannot be built without equipment.

Factors Influencing the Design of Bulk Storage Bins for Rough Rice

By Harold A. Kramer
MEMBER A.S.A.E.

THE first available record of grain storage begins at the time Joseph took charge of the grain storehouses in Egypt. From that time until the nineteenth century little information is found regarding any improved methods for the construction of grain storages. In the latter part of the eighteenth century, grain warehouses were similar to barns, crops were small and shipments few, and the farmer placed his grain in bags and transported it to the warehouse by wagon. The first floor of these warehouses was used for storing the bags of grain which were later loaded into the 24,000-lb capacity cars then supplied by the railroads.

In the year 1755, Oliver Evans was born at Newport, Delaware. To him we owe the invention and first development of the elevator "leg" which was destined eventually to change the status of the grain warehouse to that of a bulk storage system.

The village carpenter no doubt deserves the credit for the design and construction of the first bulk storage bins. His first designs probably consisted of a few rough dimensions marked off on a piece of board. As the first grain bins were little different from the old wooden barn in which Dobbin was kept, the carpenter knew to a fair extent the minimum sizes of posts and beams required to carry certain loads. He knew nothing about grain pressures but found by experience that, if certain thicknesses of lumber were not used for the walls in bins of various sizes, these walls would bulge out of shape and sometimes fail. He found that if the bins were built beyond a certain height the wood at the bottom of the bins would crush. From his experience he developed a design which used the least amount of lumber for carrying the loads, with no factor of safety provided.

Toward the latter part of the nineteenth century, as grain storages began to increase in size and become more numerous, and as insurance rates and cost of lumber began to mount, a demand arose for structures built of fire-resistant materials, such as steel and tile and later concrete. It became necessary therefore to determine as closely as possible the pressure characteristics of grain in bins. This has been done with the more common grains such as wheat, barley, rye, etc.

In recent years certain changes have occurred in the rice-producing areas of the United States which have made it desirable to adopt bulk storage to rice in place of sack storage which has been universal since the beginning of the rice industry. Some of the factors contributing to the changeover are the adoption of the combine and drier method of harvesting the rice crop, the saving made possible by eliminating the cost of sacks, and the greatly reduced labor requirements where the bulk handling method is used.

In an article by W. W. Mackie, assistant professor of agronomy, University of California, in the "Pacific Rural Press" for October 2, 1920, he says: "It has been calculated after careful conservative computation that bulk handling would save over sack handling for ordinary rice crops, all costs and losses considered, from $20 to $30 per acre."

Data compiled by the Rice Millers' Association[1] indicates that the United States is producing about 18 million barrels or 54,800,000 bu of rice annually. Only a small percentage of this crop is now handled in bulk, which means that in order to realize the savings that are possible a great deal of new construction is necessary.

A survey of the few bulk storage systems for rough rice now in existence revealed that many mistakes were made in their original construction, due mainly to the lack of available design data. The purpose of this study is to provide such data for future construction.

Characteristics of Rough Rice. Rough rice, also known as "paddy", "paddy rice", and "uncleaned rice", is threshed rice with the hulls on as it comes from the farm. Commercially, the term rough rice is used to designate the threshed rice when marketed for milling.

The seeds of the most common variety, Blue Rose, average 8.7 mm long and 3.4 mm in thickness, and 1000 average kernels weigh 29.67 grams. The glumes are pale yellow and have smooth margins. The hull loosely encloses the kernel and is yellow and thick. Its surface has a burlap appearance and is thinly covered with long white hairs which are longer and more numerous toward the tip.

Rough rice with a moisture content of 14 per cent weighs on an average about 36.2 lb per cu ft. Some of the long grain varieties weigh slightly more but seldom exceed 38.6 lb per cu ft.

Respiration. A factor of considerable importance where rice is stored in bulk is respiration, which may be defined as the release of energy through biochemical oxidation of organic compounds. Respiration is continuous as long as life remains in the kernel. Carbon dioxide and water are the chemical end products, and in addition heat is liberated. Since rice itself is a poor conductor of heat, it follows that the heat released through respiration accumulates in the mass in proportion to its bulk, and the increase in temperature may reach a dangerous level.

The rate of respiration of rice at different moisture contents was determined at the University of Minnesota with samples of threshed rice obtained from a mill at Crowley, La. The results were as shown in the following table:

RESPIRATION OF PADDY INCUBATED AT 37.8 C FOR FOUR DAYS[2]

Moisture, per cent	CO_2 respired per 24 hr for each 100 g of dry matter
10.37	0.27 mg
12.15	0.32
13.22	0.51
14.12	1.01
14.93	2.20
16.11	8.22

These data indicate that where rice is stored in bulk in any considerable quantity and for a considerable period of time, it should not have a moisture content greater than 14 per cent.

Moisture Content. To obtain data on the equilibrium moisture content of rice under South Louisiana conditions a sample of combined and artificially dried Blue Rose rice was obtained from a large bin of the Louisiana state rice mill at Lake Charles in November, 1943. Its moisture content as it came from the bin was 14.1 per cent. It was stored in a burlap sack in the agricultural engineering laboratory at Louisiana State University where

A typical sample of rough rice

This paper was presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1943, as a contribution of the Farm Structures Division.

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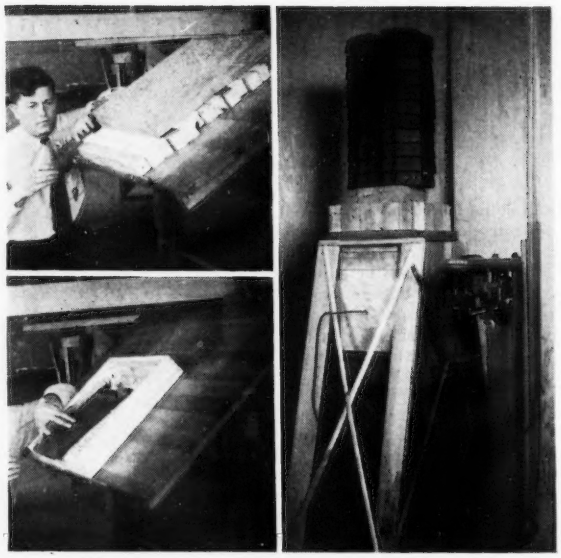
[1] "Estimate of 1943 Rice Crop." The Rice Journal, 47:9-10, January, 1944.

[2] C. H. Bailey and A. M. Gurjar, "Respiration of Rice Paddy and Milled Rice." Journal of Biological Chemistry, 44:9-12, October, 1920.

it was exposed to atmospheric temperatures and humidities, but was protected from direct contact with moisture. By March, 1944, its moisture content had dropped to 12.6 per cent, which indicates that under South Louisiana conditions rice does not ordinarily have a tendency to absorb moisture from the atmosphere in excess of the maximum of 14 per cent generally considered safe for bulk storage, as shown in the preceding table.

Rice which has been artificially dried is usually placed in storage at temperatures of from 10 to 40 deg above that of the prevailing outside atmosphere. Under these conditions there is a tendency for moisture to transfer from certain parts of the bin and to accumulate at or near the top center of the mass. This same tendency has been observed with soybeans[3].



These views show the equipment used for measuring (left, top) the coefficient of friction of rough rice, (left, bottom) the angle of repose and (right) the ratio of lateral to vertical pressure, k

Angle of Repose. The angle of repose for rice, or the coefficient of friction of rice on rice, u, was measured by filling a light wooden frame, mounted on a tilting-top drafting table, with rice. The table top was then tilted until a part of the rice spilled over the lower edge of the frame leaving an inclined surface which was the angle of repose for that particular sample. The inclined surface was measured by means of a plumb bob and protractor. The angle of repose was determined for the most common variety of rice, Blue Rose, and also for Rexora, which is typical of the long grain rices.

It was found that the angle of repose is greatly influenced by moisture content, especially when it exceeds 16 to 17 per cent. At higher moistures it increases very rapidly. The values given in the following table are for rice with 14 per cent moisture. The results obtained were very consistent and for the same sample seldom varied more than plus or minus one per cent from the mean.

ANGLE OF REPOSE FOR RICE

Variety	Angle of repose, deg	Coefficient of friction of rice on rice (tangent of angle)
Blue Rose	36	0.727
Rexora	34	0.675

Coefficient of Friction. The coefficient of friction, u[3], of rice on various bin materials is of particular importance to the bin designer because of its influence on bin pressures, and also on the required slope for hopper bottoms and any spouting to and from the bin proper.

The method used to determine the coefficient of friction was essentially the same as that for determining the angle of repose, except that a sample of the bin material to be tested was first placed between the wooden frame and the tilting table top. The bin material was fixed to the table top, but the frame and contents were left free. The rice was carefully poured into the frame and leveled even with the top edges. The table was tilted until the angle was reached at which gravity overcame the frictional force between the rice and bin material, and movement began down the slope.

It was found that additional weight placed on the top surface of the rice had no significant effect on the angle at which movement began. This is to be expected, as the coefficient of friction is independent, within reasonable limits, of pressure per unit area.

Ratio of Lateral to Vertical Pressures. The ratio of lateral to vertical pressures, k, for rice was determined with a small model bin two feet deep and one square foot in cross-sectional area. The bin was equipped with hydraulic type pressure gauges at the side and bottom. When vertical pressure was applied at the top surface of the rice, the resultant pressure at the bottom and side could be determined by measuring the increased height of the water columns connected to the respective gauges.

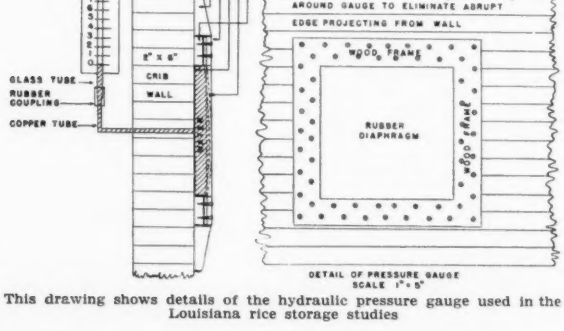
COEFFICIENT OF FRICTION FOR RICE OF 14 PER CENT MOISTURE CONTENT

	Blue Rose	Rexora
Rice on flat galvanized iron	0.402-0.414	0.447-0.449
Rice on concrete (smooth finish)	0.516-0.531	0.461-0.473
Rice on wood (plywood, across grain)	0.495-0.500	0.530-0.542
Rice on wood (plywood, with grain)	0.435-0.440	0.500-0.506
Rice on wood (cribbed wall)	0.583-0.613	

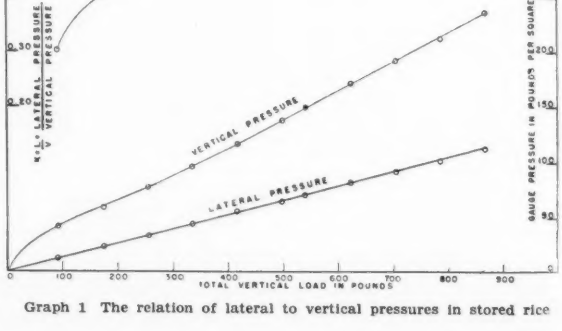
A series of tests was made using gradually increased loadings up to a maximum of 868 lb which was the practical limit with the equipment being used. Graph 1 shows that k increases very rapidly at low pressures, but soon reaches and maintains a constant level for the remainder of the range of pressures applied.

In examining graph 1 it is noted that only about 27 per cent of the total vertical load was transmitted through the two-foot column of rice to the bottom gauge. This surprising result was verified by several tests in which the walls of the bin were sup-

[3]Deane G. Carter and M. D. Farrar, "Redistribution of Moisture in Soybean Bins." AGRICULTURAL ENGINEERING, 24:296, September, 1943.



This drawing shows details of the hydraulic pressure gauge used in the Louisiana rice storage studies



Graph 1 The relation of lateral to vertical pressures in stored rice

ported separately from the floor, while the bin bottom only rested on a platform scale. This experiment also checked the accuracy of the pressure gauge in that the pressure indicated by the water column checked very closely with the actual pressure as shown by the platform scale.

General Requirements of Rough Rice Storage Bins. A fundamental requirement of a bulk storage system for rice is that it adequately protect the contents of the bins from atmospheric moisture. This point is emphasized because in a number of cases bulk storage of rice was condemned as unsatisfactory where upon further investigation it was found that leaks in the roof or around the eaves or sidewalls of the structure permitted driving rains to enter and dampen the rice, causing spoilage. A great deal of rice is also damaged each year by the action of weevils and by rats. With proper construction these losses can be greatly minimized.

In the rice areas along the Gulf Coast, in Louisiana and Texas, tropical storms accompanied by winds of high velocity make it necessary to give special attention to wind bracing. This is especially important where wooden frame construction is used, because the storage structure is often empty a part of the year and then the ratio between the surface exposed to weight of the structure is large.

Ventilation. The importance of good ventilation has long been recognized for all types of grain structures. When artificially dried rice is stored it is of even more importance because the warm rice coming from the drier enters the bins before cooling to atmospheric temperature. As long as heat is given off by the rice the temperature of the air immediately above the rice will be higher than that of the atmosphere. This warm air tends to absorb moisture from the rice and/or other air, and, if it is not allowed to escape by circulation, may eventually come in contact with a cold surface and condense. In the case of a steel or concrete bin this may occur on the sidewalls when the bin is not entirely filled. A metal roof is another point where condensation often occurs.

Bin Size and Conformation. A bulk storage system for rice must have a sufficient number of bins to store each variety separately. Since the average rice grower will ordinarily grow as many as four different varieties, to spread his harvesting season over a longer period, a minimum of four bins is required in the most simple system. Where an artificial drier is used, additional work bins are needed for storage of partially dried rice. As a general rule from ten to fourteen bins should be provided where the total capacity does not exceed 10,000 barrels.

The most popular rice combines now in use in Louisiana have a maximum daily harvesting capacity of about 250 to 300 barrels. Combined rice must be artificially dried, and it is common practice to dry the rice from two to four separate times on consecutive days. It is believed that one combine will have sufficient capacity for the average rice grower in Louisiana. Where this is the case four working bins should be provided, each of at least 250 to 300 barrels capacity. The working bins can best be provided by partitioning the two full-size bins nearest the drier.

The commercial rice driers now available require a space about 16 by 22 feet by 40 feet high. To accommodate a drier of this height the work house (part of structure in which drier and elevators are located) must be about 50 ft in height. Where a work house of this height is used, it is economical to construct the storage bins a minimum of 30 ft deep rather than of less depth and greater cross section, thus simplifying to some extent the conveying system.

Since the rice must be frequently moved the labor required for this should be reduced to a minimum. All bins should be hoppered at the bottom so they will empty entirely by gravity. For dry rice a 45-deg slope is satisfactory where the valley angle is lined with smooth tin. For bins which will handle damp rice such as the working bins, the hopper slope should be increased to 60 deg.

Handling and Conveying Equipment. The conveying and elevating equipment for a bulk handling plant is very important and deserves careful study. This equipment receives a great deal of use and in any case should have a capacity equal to that of the drier. For a small bulk storage an 8x5-in cup with a 9-in auger is about the minimum size. In most installations where a drier is used a minimum of three elevators is desirable—one for moving rice from the unloading pit to drier or bin, one from the drier to bins, and another from bin to drier or bin to bin. With this arrangement it is possible to unload rice from the combine at the same time other rice is being dried. Where a double row of bins is used which are individually hoppered at the center, a fourth elevator is desirable, which will permit "loading out" rice into trucks or box cars at the same time other operations are going on.

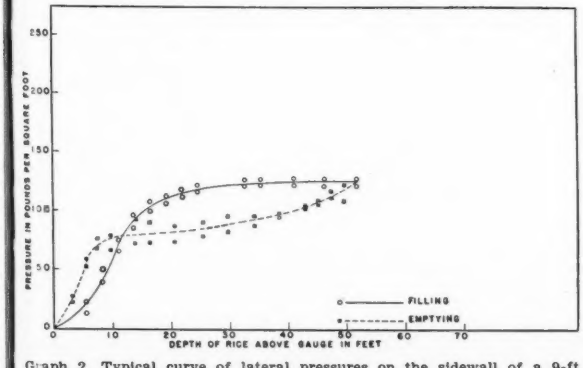
To prevent undue mixing of rice varieties all elevator boots and conveyors should be made readily accessible for cleaning. Experienced rice buyers can readily detect if there is even a small amount of another variety mixed in the rice they are buying, and usually they discriminate rather severely against it.

An unloading pit should be provided for rice coming in for storage. A concrete pit with a ramp leading toward and away from it makes a good arrangement. It can be covered with a grating and provided with some type of hoist for dumping the rice from truck or trailer. The slope of the hopper bottom should be a minimum of 60 deg. Where a pit is used care must be taken during construction to insure a waterproof job.

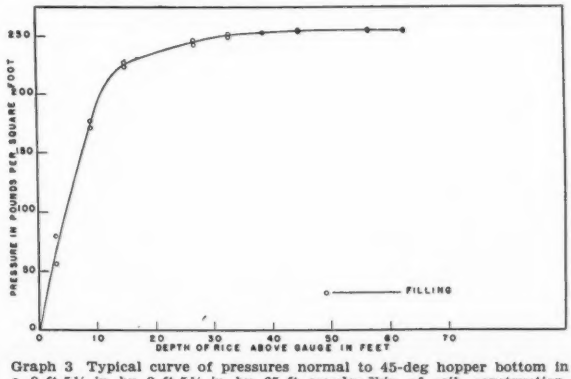
Combined rice often contains considerable foreign matter with a high moisture content, such as short lengths of straw and pieces of green leaves and berries from weeds. This, if allowed to remain, may give trouble by preventing a uniform flow of rice through the drier, and later tend to cause heating in storage. It is advisable to use some type of cleaning device for removing this material. A machine such as a No. 6 Monitor cleaner is of about the right size for the smaller storage plants.

Fire Protection. A bulk storage system for rice presents a fire hazard, especially when equipment for drying rice is housed in the same building, as is usually the case. The transferring of the rice from bin to bin and from bin to drier and return causes considerable dust to accumulate which, if mixed in the right proportions with air, is easily set off as an explosion by a spark or flame. The U. S. Department of Agriculture, through its Bureau of Chemistry, has issued a bulletin, entitled "Dust Control in Grain Elevators", Department Bulletin No. 1373, which has many helpful suggestions to anyone interested in having a dust-free plant.

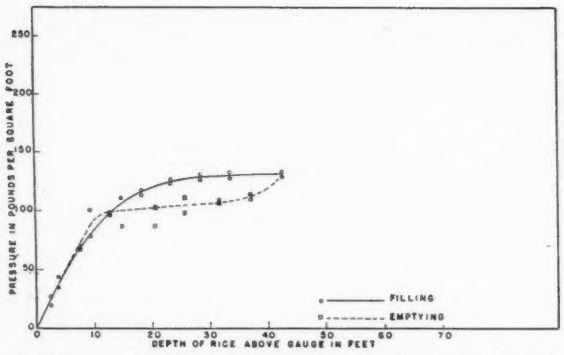
Where new construction is contemplated the local insurance companies should be consulted as to their rates for different types of construction. Frequently only a small change in design will re-



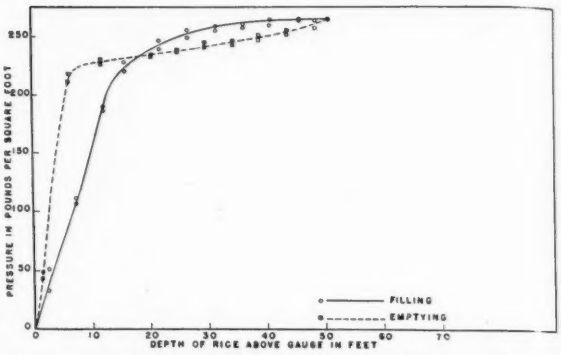
Graph 2 Typical curve of lateral pressures on the sidewall of a 9-ft 5½-in by 9-ft 5½-in by 65-ft wooden bin of crib construction, filled with Blue Rose rice



Graph 3 Typical curve of pressures normal to 45-deg hopper bottom in a 9-ft 5½-in by 9-ft 5½-in by 65-ft wooden bin of crib construction, filled with Blue Rose rice



Graph 4 Typical curve of lateral pressures on sidewall of 9-ft 5½-in by 9-ft 5½-in by 65-ft wooden bin of crib construction, filled with Rexora rice



Graph 5 Typical curve of pressures normal to 45-deg hopper bottom in a 9-ft 5½-in by 9-ft 5½-in by 65-ft wooden bin of crib construction, filled with Rexora rice

duce the insurance rate all out of proportion to the small additional expenditure required.

Strength Requirements of Rough Rice Storage Bins. Rice is a granular material. The pressures exerted by it when stored within a bin do not follow the laws of fluid pressure. To determine the pressures which are exerted it was necessary to construct special gauges for actually measuring pressures in existing full-size bulk storage bins of various sizes.

The gauges used were of the hydraulic type. The liquid used in the gauges was water colored with potassium dichromate. This made calculation of the pressures very simple as it was only necessary to multiply the gauge height in feet by 62.4 lb to obtain the bin pressure in pounds per square foot. Other reasons for using this type gauge were that it was not necessary to cut a section out of the existing bin wall or floor to install the gauge; the pressures could be read at a convenient point outside the bin and it was not necessary to calibrate the gauges other than to determine the zero pressure reading or water level in the vertical glass tubes.

Most of the bin pressure measurements were made at the bulk storage plant of the Louisiana state rice mill at Lake Charles, where there are rice bins 65 ft deep.

Two separate gauges were installed side by side on the bin wall 6 ft above the hopper bottom, and two additional gauges were placed on the 45-deg slope of the hopper bottom. Two-inch lumber was used to frame around the gauges to hold them securely in place, and also on the assumption that a projecting edge at the gauge might affect the true pressures, especially when the bin was being emptied.

The conveying and elevating equipment for filling and emptying the test bin was known to be very consistent in its rate of feed. The depth of rice in the bin at any time could therefore be calculated by the ratio of the time that had elapsed since beginning to fill or empty the bin to the total time required to fill or empty the bin.

The rice used for the pressure tests was Blue Rose and Rexora. The majority of it had been harvested in the vicinity of Lake Charles with rice binders and had been shocked and threshed in the customary manner. Upon arrival at the mill the sacks were emptied into an unloading pit and the rice was transferred by elevators to the large bulk storage bins. The rice was all of good average quality and its moisture content ranged from 13.9 to 14.2 per cent.

Because of the time and equipment required in making the pressure tests data were obtained only on the two varieties of rice mentioned above. The test bin was filled five times with Blue Rose and three times with Rexora. This required a total transfer, from bin to bin, of over 1400 tons of rice. Actual data obtained from the pressure tests are shown in graphs 2, 3, 4, and 5.

In several instances the test bin was not emptied until twenty-four hours after filling, and in one instance a week elapsed before it was emptied. In each case where a delay occurred before emptying began, it was noted that the maximum bin pressure occurred immediately after filling and then decreased for a period of time before becoming constant. The unloading curves shown on graphs 2, 4, and 5 indicate that the emptying pressures in rice bins are very similar to those obtained with wheat. A part of the results of some pressure tests made on full size wheat bins 80 ft deep at Buenos Aires, Argentina, is quoted as follows: "The pressure at which the unloading curve begins is usually very considerably below the pressure observed for the same depth of grain during filling. Throughout a large part of the process of emptying the bin, the pressure remains at approximately the same height or even is higher than the pressure for the same depth during bin filling. Only in the last six feet is a very rapid decrease observed."[4]

The true vertical pressures which occur in rice bins were not measured because all the full-size bins available for testing had sloping hopper bottoms. The vertical pressures, however, may be calculated from the lateral pressure where k, the ratio between the lateral and vertical pressures, is known. This ratio was determined for various pressures by means of the model bin already described. These data are shown in graph 1.

When the total vertical load on the bin floor is known, the total load carried by the bin walls may be calculated by subtracting the floor load from the weight of the entire contents of the bin. In the case of the test bin filled with Blue Rose rice to a depth of 52 ft, the total weight of the contents was 185,565 lb while the maximum vertical floor load was calculated to be 23,740 lb. This indicates that the walls were carrying 87.2 per cent of the total weight of the contents. At first thought the high percentage of total weight carried by the walls of deep bins seems incredible, but it has already been shown by tests made with the small model bin, where the bin wall was supported from the floor and the bottom rested on a platform scale, that this condition does exist.

To show further the difference in the problem of designing a bin for rice or for a liquid with the same specific gravity as rice, let us again consider the full-size test bin with which we are already familiar. This bin, when filled with Blue Rose rice to a depth of 52 ft, will have a vertical floor pressure of only 12.8 per cent, and a lateral wall pressure of only 6.8 per cent of the pressure that would be produced by a fluid of the same specific gravity as the rice. The walls, however, are required to have sufficient strength, acting as a column, to support over 87.2 per cent of the total weight of the rice in the bin, while if the bin contained a fluid they would have no load to carry beyond their own weight. On the other hand, it is practical to design a tank or standpipe that will have an ample margin of safety when filled with a liquid, but which would undoubtedly fail when used for the storage of rice.

[4]Eckhardt Lufft, M. E., "Tests of Grain Pressures in Deep Bins at Buenos Aires, Argentina." Engineering News, vol. 52, no. 24, pp. 631-32, December 15, 1904.

Fire Fighting Methods and Equipment

(Continued from page 458)

neers can help by suggesting practical methods under the prevailing conditions.

This is both an opportunity for agricultural engineers to render another fine service to their farm communities and a challenge to clear, straight thinking by all of us to reduce the loss of 3,300 lives of farm people each year and the loss of $225,000,000 worth of property.

Development of Agricultural Land for Irrigation

By William O. Wallinder
MEMBER A.S.A.E.

DEVELOPMENT of agricultural land for irrigation is not as new as is commonly thought. Long before the dawn of present-day history, ancient tribes of southwestern United States built large canals and laterals to irrigate thousands of acres of land. The land was divided into family or tribal farms in a manner closely resembling our modern methods of subdivision. Archaeology of the region indicates that these ancient fields were carefully leveled and watered with effective results.

During modern times many advancements have been made in the land development phases of irrigation practice. Many methods now used have resulted from years of pioneering and experimenting by individual farmers who first settled the raw lands of western reclamation projects. The expensive and technical job of getting raw land into efficient production under irrigation called for clearing away native growth, leveling land, plotting fields, and laying out farm distribution and drainage systems.

Originally it was thought that land development work could be done by the farmer between busy seasons and along with his ordinary farming operations. But the load proved to be too heavy, and often two or more generations of operators tried and failed before a satisfactory job was accomplished. Modern methods of land development bring into play careful planning, designing, and supervision by trained technicians as well as the use of revolutionary, heavy-duty, earth-moving equipment which has largely removed the obstacle of high per-acre cost.

Since the term "agricultural land development" has been rather loosely applied to many phases of work incident to crop production, a general definition of the term as used in this paper is given as follows: Agricultural land development is the modification of the land profile (through land leveling), shaping, and planning the layout of farms and fields, and the construction and installation of farm irrigation and drainage ditches and control structures so as to insure maximum economy and efficiency in the application and use of irrigation water. All modification work is based on detailed soil, land classification, and topographic surveys, and future land use.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis., June, 1944, as a contribution of the Soil and Water Division.

WILLIAM O. WALLINDER is civil engineer, water conservation and utilization division, Farm Security Administration, U. S. Department of Agriculture.

TYPES OF PROJECT AREAS

Agricultural land development may be applied to all types of irrigation projects, but in this discussion only valley bottom lands and valley bench lands will be considered since the author's experience has been limited for the most part to development of these land types. Problems encountered in each land type will vary considerably, but the ultimate objective is the same, namely, maximum economy and efficiency both in the land development itself and in subsequent crop production.

To arrive at a common understanding and to set forth clearly the characteristics of the land surface in the valley bottom and bench lands the following descriptions are important:

Common Characteristics of River Bottom Land.

1 The greatest natural slope or grade of river bottom land is usually in the direction of the stream flow and varies from 0.1 ft in 100 ft to 0.5 ft in 100 ft.

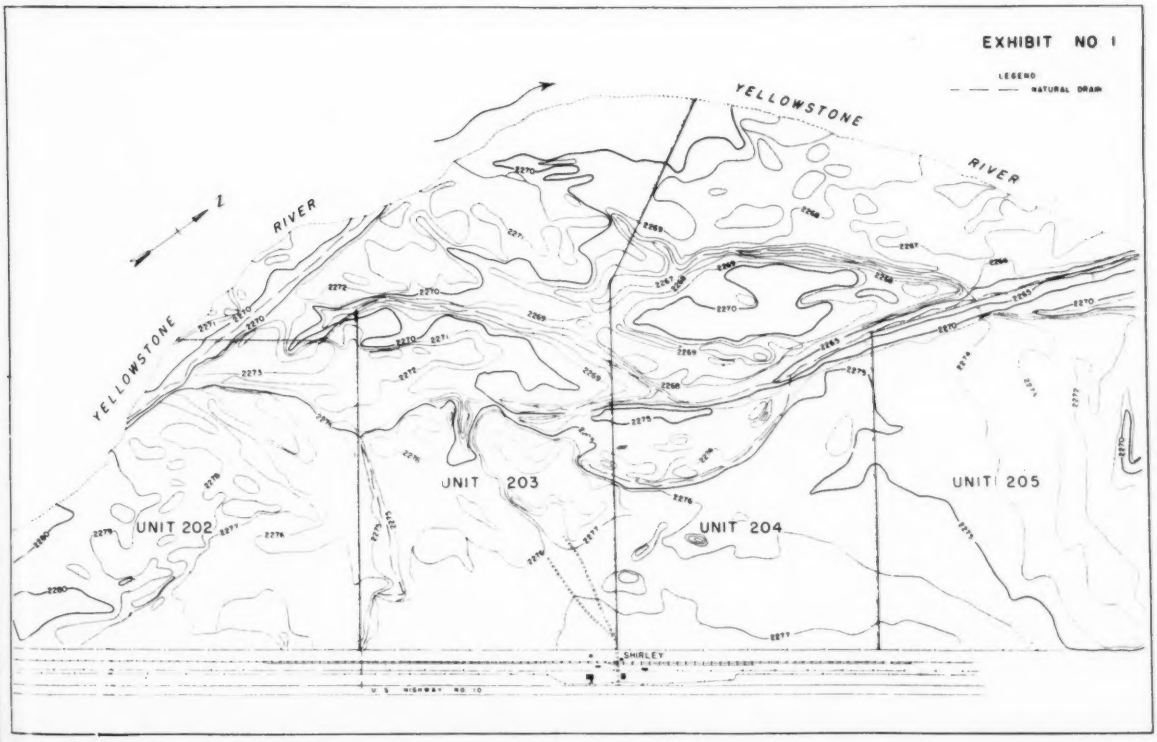
2 Soils are recent alluvial deposits with many type and textural variations and with a top soil depth of from 7 to 36 in. Top soils vary from silty loams to very fine silty loams with some lighter textured soils interspersed in relatively small areas.

3 Topography is usually hummocky and very rough.

4 Some of the area may be covered with trees and underbrush and require difficult clearing operations.

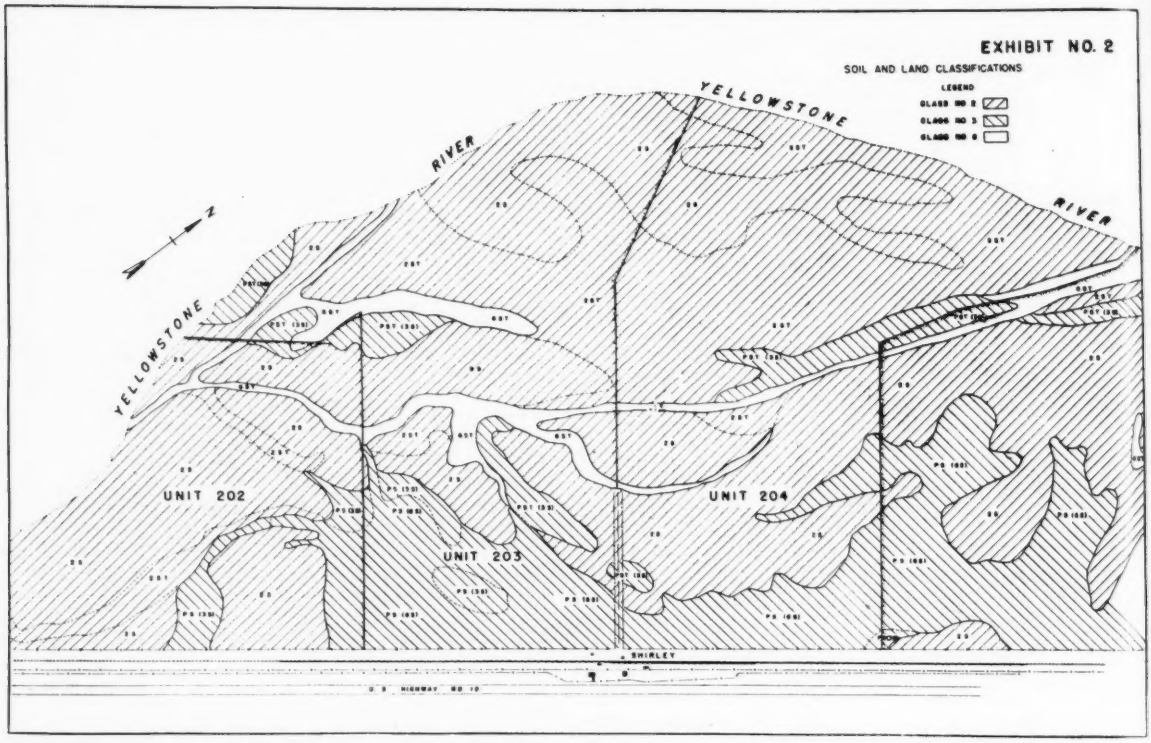
5 Due to the floorlike position of river bottom lands, flood waters from higher lands or from river overflow may cover parts of the areas at times.

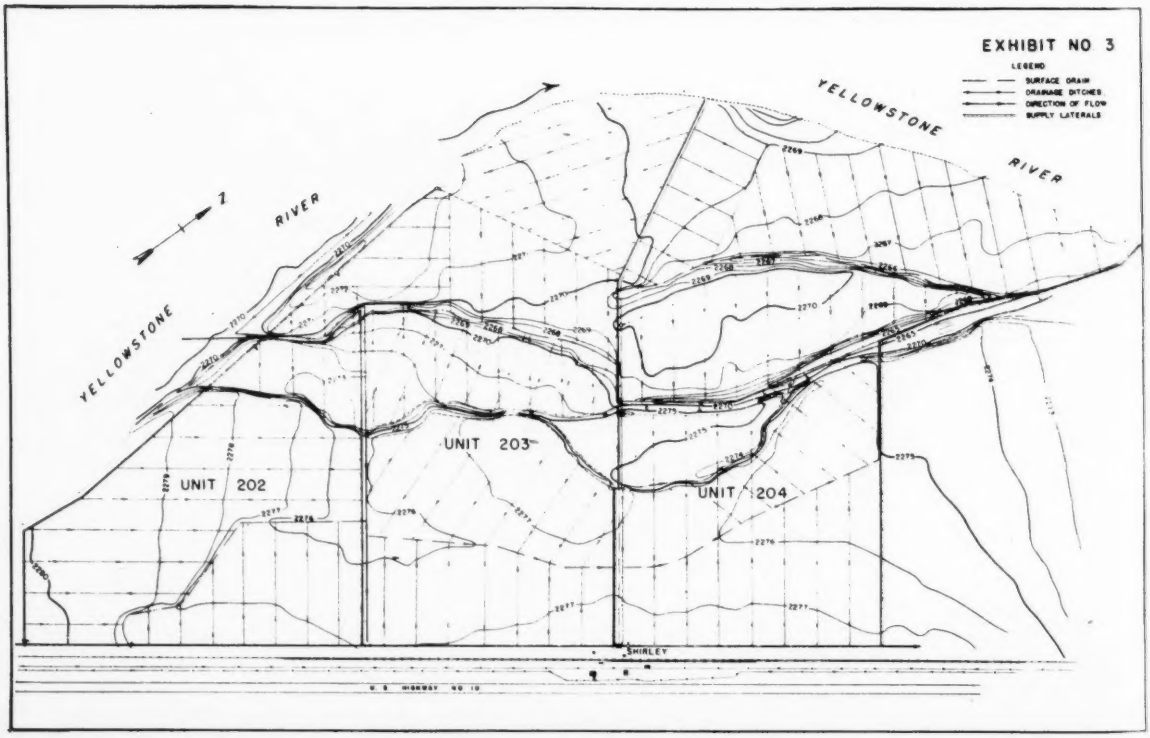
A few projects which come under this classification are: The



Milk River project, Buffalo Rapids second division, and the lower terraces of the Lower Yellowstone, all in the state of Montana. The Buford-Trenton project in North Dakota also falls into this classification.

On river-bottom land, land development usually consists of the following major operations: (a) Land clearing; (b) land leveling of a medium, heavy, or extra heavy character; (c) careful design and construction of the irrigation distribution and drainage systems because of the natural flatness of the land; (d) careful layout of farm units and farm fields according to physical land characteristics.





Common Characteristics of Valley Bench Lands.

1 The natural slope or grade is usually greatest in a direction extending from the uplands toward the river and varies from 0.5 ft per 100 ft to as much as 5 ft per 100 ft.

2 The soils are of an old, alluvial type with little variation in type and texture, and are often underlain with gravel beds or hard pan. The top soil may be shallow ranging in depth from 7 to 14 in.

3 The land surface is generally smooth with large areas similar in topography and soil types lying in one block.

4 There is very little underbrush and trees.

5 Cross drainage from the uplands often crosses the benches eroding gulleys or at least forming definite drainage channels.

Projects which fall into this classification are Buffalo Rapids, first division, and the upper terraces of the Lower Yellowstone, both in Montana, and the Mirage Flats project in western Nebraska.

On valley bench lands, land development usually consists of the following operations: (a) Minor land clearing activities; (b) land leveling which is restricted to light and medium classifications; (c) careful design and construction of the irrigation distribution system and careful use of control structures to prevent excessive soil erosion, and (d) careful design of surface drainage to take care of excessive cross drainage from the hills.

TECHNICAL DATA

Since all classes of land within the project boundaries enter into the over-all development scheme to some degree, and since land development deals almost exclusively with soils and topography, it is necessary to prepare complete and detailed soils and land classification and topographic maps before a comprehensive plan of land development for an area can be settled upon.

On the Buffalo Rapids project in Montana we have successfully used maps made on a scale of 200 ft to the inch. In the preparation of a soils map 6 to 12 samples were taken in each 40-acre block depending upon soil variations.

A detailed topographic map is the key to economical land development. It would be difficult to overemphasize the importance of having accurate information on the rise and fall of the land surface. On valley bottom lands, field experience has proven that a satisfactory topographic map, for the purpose of land leveling and other field operations, can be made by running contours at intervals of one foot. The topographic map should be made on a scale of 200 ft to the inch. On valley bench lands, where the natural surface slope is greater and where there is more uniformity in both topography and soils, the topographic map may be on a scale of 400 ft to the inch.

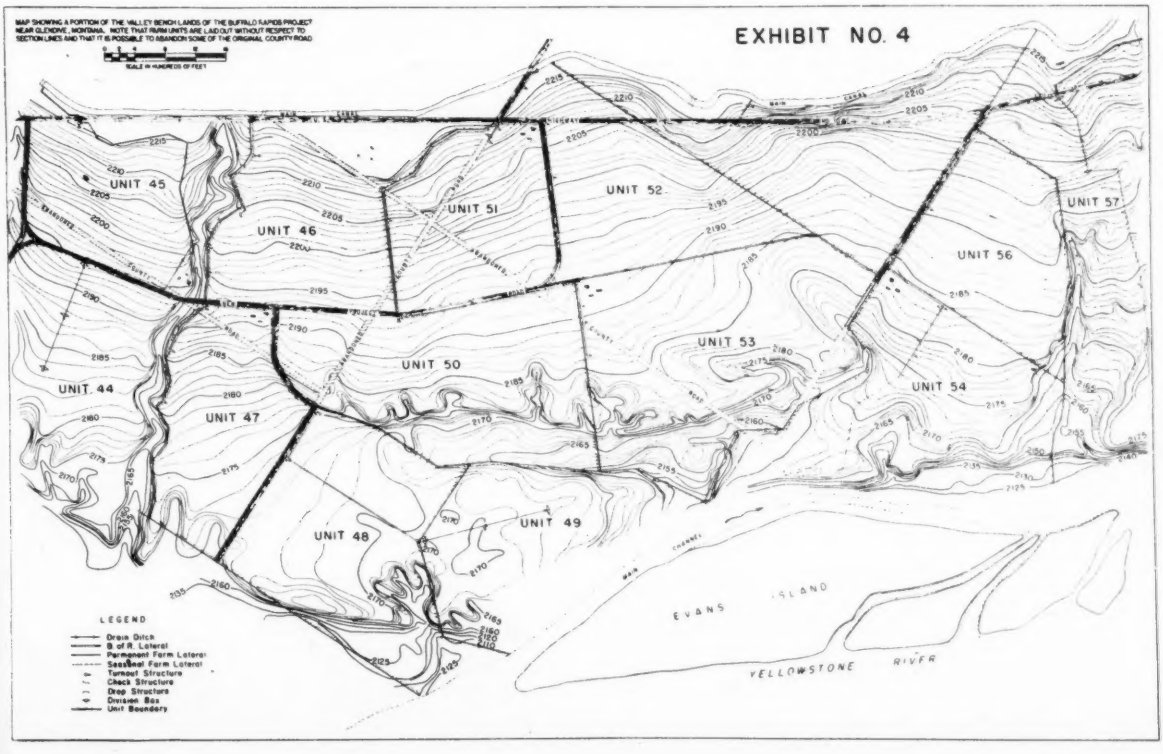
DETAILED PLANNING AND DEVELOPMENT

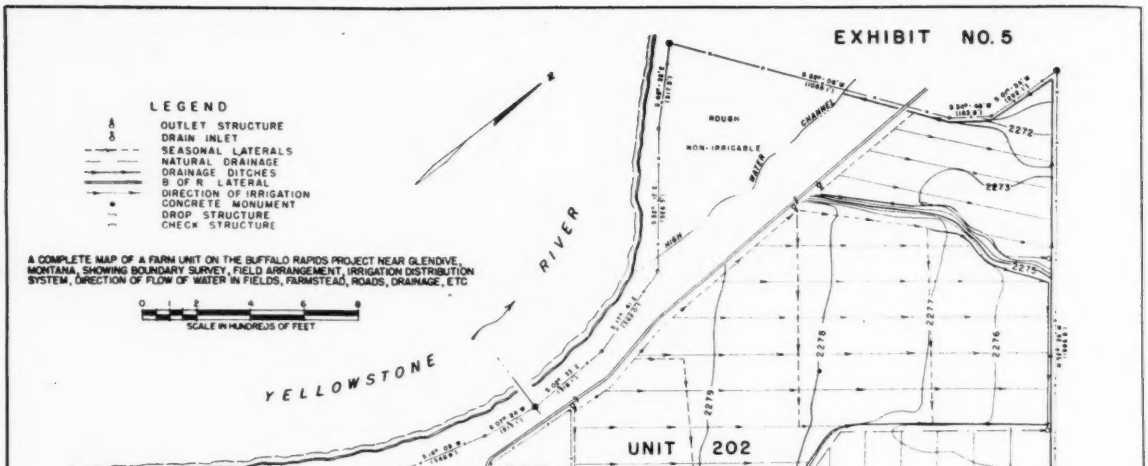
Experience and data obtained in development of the Buffalo Rapids project, second division, which is a good example of valley bottom lands, will serve as a basis for explaining the procedure now employed for land development planning on all water conservation and utilization projects of the Farm Security Administration.

Exhibit No. 1 is the original topographic map of a subarea of the project which lies almost wholly on the same terrace or elevation. The location of the natural drainage courses and the placing of the distribution system for delivering irrigation water to the land were made after careful study of the topographic features. A study was then made of the soils and land classification map shown in exhibit No. 2. Acreages of Class 2, 3, and 6 lands were computed by use of a planimeter. In this area there were 480 irrigable acres distributed among the above classifications. Detailed farm plans for the area, correlated with the land classification, indicated that each farm unit should contain 110 to 120 acres of irrigable farm land. Class 2 land predominated and accordingly this subarea was divided into four farm units.

The size of adequate family farm units is determined by estimating the anticipated productive capacity of each class of land after it is developed and put under irrigation. Subdividing a given area of irrigable land into farm units requires careful planning to make certain that each farm unit has approximately the same productive capacity, that each is sufficient to maintain a farm family with a reasonable standard of living, and that each can meet the necessary annual expenses for operation and for retiring capital indebtedness. Estimates are all based on long-time earning values.

The next step is to study the topographic map along with the soils and land classification map in order to fix the specific boundary lines of individual farm units. These unit boundaries are fixed by the following process: (1) By visualizing what the topography of the land surface will be after leveling, (2) by studying the location of drains and main supply laterals, (3) by visualizing field arrange-





ments to select easy ways of water application, and (4) by putting into each field, in so far as possible, soils of like characteristics. The size of the unit is determined by estimating the productive capacity of the land and the number of acres necessary to constitute a family-size farm under longtime average agricultural and economic conditions.

The next step consists of laying out on the map a coordinate system for land leveling. This consists of delineating on the map areas in which the soils and topography are suitable for leveling in one block. In each such area an attempt is made to produce a land surface on which good water distribution and drainage can be secured by moving the least possible amount of dirt. In choosing these areas it is necessary to lay out leveling lanes in such a way that soils of unlike characteristics will not overlap.

The area shown in exhibits 1 and 2 presented a problem because it contains several soil types from very fine sands to heavy clay. This is especially true on units 203 and 204. When the land-leveling grade stakes were set on these units, fields with the same or similar soil characteristics were leveled in one piece. Fields with unlike soil characteristics were separated from each other by a surface drain. When a unit is laid out in this manner, it is possible for the farm operator to distribute irrigation water with minimum effort and maximum benefit.

After land leveling has been accomplished as outlined, a new topographic map is prepared showing the new characteristics of the land surface, as shown in exhibit 3. On this map is shown the farm irrigation distribution system including the permanent and seasonal ditches, irrigation structures, surface and deep drainage, and such other items as road crossings, entrance roads, and farmsteads.

By making a comparison of exhibits 1 and 3 it becomes clearly evident that almost every aspect of agricultural land development has been encountered in the process.

Development of a valley bench land as compared with bottom land does not require as much detailed planning since soil types are less varied, the land surface is usually more smooth, and there are fewer trees and often no underbrush to be cleared. Exhibit 4 brings out the characteristics of lands that lie on the upper terraces. By comparing exhibit 4 with exhibit 3 it is possible to note the differences which exist between lands lying in the two locations after development.

GENERAL CAUTIONS, GUIDES, AND RESULTS

There are a few general points upon which the success of agricultural land development work depends to a large extent and which should be discussed. In many of the older irrigation projects operating in the western states, the farms were laid out on the basis of legal subdivisions from the original land surveys. In other words, townships were cut into sections and sections into rectangular farm units of 80, 120, or 160 acres. Irrigation canals, laterals, and drainage ditches necessarily follow land contours and therefore must follow courses across the countryside which seldom are parallel to section lines. These circumstances usually mean that a rectangular farm unit is crossed by several ditches in such a way as to form several small, irregular, three-cornered fields which were difficult to reach and to farm. The many disadvantages of this system are obvious, and therefore need no further discussion here.

It should be reiterated, however, that the farm unit subdivision on the Buffalo Rapids area under discussion was done on the basis of topographic features instead of legal subdivision. Several important guides to efficient farm unit subdivision are (1) the slope and character of the land surface, (2) the location of main structural features such as drainage and irrigation ditches, and (3) desirable field arrangements to facilitate cultivation and water distribution. By following these guides in laying out farms, it is possible to reduce the original cost of construction and land development, to reduce future operation and maintenance costs, and to increase farm income through saving of irrigation labor and increasing crop yields.

On exhibit 4 it should be noted that the farm unit boundaries are nearly perpendicular or parallel to the contours and that supply laterals are located on farm unit boundaries as far as possible. It is significant that a farm unit sometimes lies in as many as four different sections, yet only one water delivery point is necessary. If the units had been laid out according to legal subdivisions, four points of water delivery might have been necessary to serve the same area.

In almost all cases careful planning of subdivisions not only eliminates the amount of road required to service each unit, but also permits each farmstead to be adjacent to a county road (see exhibit 4). This largely eliminates stub roads and lengthy farm entrance roads which are common in *(Continued on page 478)*

Agricultural Engineering

By J. Brownlee Davidson
CHARTER MEMBER A.S.A.E.

IT IS the acknowledged purpose of this paper to enlist the interest and secure the moral support of a larger group of members of the Society for the Promotion of Engineering Education in a new branch of the engineering profession. The development of agricultural engineering is worthy of their assistance and encouragement. Although the record for agricultural engineering is one of accomplishment, it is felt that progress has not been made as rapidly as the circumstances justify. It is very much desired that engineering educators consider the possibilities in this branch of engineering and lend it support, as I believe circumstances will fully warrant.

May I undertake to describe and define the field of agricultural engineering. In earlier years I would not have undertaken to do this, because I would have considered it unnecessary if not presumptious. But nothing, I believe, will contribute more toward a meeting of minds than to start our thinking from a common and an accepted viewpoint. Even after these many years I am often asked, "What is agricultural engineering?" Let us explore the field and establish the areas of interest.

Agricultural Engineering Defined. Many of the conventional definitions for engineering include three central interests, described by three typical phrases, namely, (1) the organization and direction of men, (2) the application of the forces of nature, and (3) the utilization of the materials of nature. In the accepted concept of engineering these three central interests are combined into a program for the production of commodities and services contributing to the well-being of man or the human race as the definitions may read. Using more common terms, these central interests of the engineer are "labor", "power" and "materials". We may expect that the general interests of an agricultural engineer are the same as other representatives of the engineering profession.

It is frequently pointed out, and I mention it in review for the purpose of building up a common approach, that engineering may be classified as to the character and nature of the engineering problems and techniques involved, such as civil engineering or mechanical engineering. But it is likewise a matter of precedent extending back over many years, to organize engineering about an industry, mining engineering being the oldest example. The first classification is in a sense a vertical division, while the latter is a horizontal division. Agricultural engineering is similar to mining engineering in that it is the engineering organized about an industry — about agriculture. I might outline and describe the distinctive branches of agricultural engineering which have developed: power and machinery, farm structures, and soil and water conservation.

But it seems we should be concerned with the principal engineering interests as they are related in agriculture. Consider labor first. The engineer should be a specialist in labor efficiency. The 1940 U. S. Census reports that 18.5 per cent of the persons gainfully occupied are in agriculture. The per cent for manufacturing of all kinds is 23.4 per cent, only one-fourth greater than that for agriculture. Those employed in transportation, communication, and utilities are 6.9 per cent of all, or a little over one-third of those in agriculture, while the per cent for mining is 2 per cent, or only one-ninth of the workers in agriculture.

Power. Let us next consider the use of power, or energy to be more exact. The 1940 census credits all manufacturing as using 21 million horsepower in prime movers and 29 million horsepower in purchased energy, or a total of 50 million horsepower. It is necessary to resort to an estimate of the primary power used in agriculture. Such an estimate for 1940 is 97 million horsepower. It is recognized, however, that the actual energy used in horsepower-hours by agriculture and the manufacturing industries may be quite a different matter.

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Materials. As to materials, agriculture is an extensive user of materials of construction, though I am not able to make comparisons for you. However, the census indicates that the actual value of farm buildings is over 10 billion dollars, of which the replacement cost is thought to be about 30 billions. The farmer must not only house his family, but his livestock, his crops, and his equipment. Accepted data indicate that expenditures for farm structures have in the last decade varied from 140 to 900 million dollars and the purchase of farm machinery has varied from 300 to 700 million dollars.

Such is the agricultural engineer's stake in the three central interests of the engineer — labor, power, and materials. But is there the opportunity to apply engineer-engineering methods and techniques to agriculture? Occasionally and less frequently than formerly, it is suggested that there is little room for the practice of engineering in agriculture. Let us consider just one illustration, the production of one crop. Iowa is in the center of the corn belt. The state in 1943 grew 11 million acres of corn yielding a crop worth over a half billion dollars. The Iowa Agricultural Experiment Station has supported extensive engineering studies of corn production.

What is the technique of producing corn? True, it is necessary to start with the best agronomic program available; the soil management program should be according to the most modern conception of the sciences involved, and it is necessary to have the right kind of seed and be equipped with a knowledge of the culture of the corn plant. But the actual production of the crop, after all these have been provided and arranged for, which consists in the preparation of the seedbed, the planting of the seed in the right amount to the right depth, the fight on weeds and finally the harvesting of the crop, is accomplished by labor and by power applied through machines — the emblems of the engineer's art. There are many considerations in the production of corn, but none are more important than the man-hours of labor, the horsepower-hours of energy, and the expenditures for machinery and equipment. Standards of performance are just as important here as in the factory. To state that under certain conditions, to produce an acre of corn, it requires 4 man-hours of labor, 35 horsepower-hours of power and an annual expenditure of one dollar per acre for the use of machines, rings just as true to the engineer as any data you may quote from any production enterprise.

It may be appropriate to consider briefly the special significance of the industry to which agricultural engineering is related. This is matter of inspiration to the agricultural engineer and should be of some interest to all engineers. First, it should be pointed out that agriculture is a primary industry in which all must be interested because agriculture supplies food and raw materials for food, shelter and clothing, and these are elemental needs of all. The only other industries that approach agriculture in this respect are homemaking, the basis of civilization, and education, the task of transferring to the coming generation such knowledge and experience from the past as can be passed on.

So far I have tried to point out something of the scope and nature of agricultural engineering. In addition, I would like to present three other matters for your consideration.

Agricultural Engineering Is Exacting and Difficult. From time to time I meet engineers who go out of their way to explain that agricultural engineering is very elementary and stands much below the high standards for other branches of the engineering profession. Such men are in my opinion revealing a lack of an intimate knowledge of the engineering problems of agriculture. One of my particular interests is machine design, and I have met machine designers who are contemptuous of farm machines. In a few instances I know, men with these views have undertaken to show up the resourceful and ingenious farm equipment designer, only to find that they have overlooked the economic limitations as well as the condition of exposure and rough usage to which the machines are subject.

A few years ago an engineer with particularly fine training, in-

cluding graduate work leading to a doctorate degree in addition to a conventional curriculum in engineering, and with extended experience in design, particularly centrifugal pumps and airplanes, was employed by a western institution to work on orchard heating problems. He has stated that although the first two lines of design were recognized as representing a rather high order of mechanical knowledge and skill, this new work was much more difficult. Not only were the usual design problems present but meteorological and biological relationships were involved. This has been the experience of many other engineers.

The division of agriculture into over 6 million units of farms with individual management means that engineering techniques must be introduced in a way applicable to the conditions to be met. Mining is organized into 12 thousand units, or 1/500 as many establishments. This does not mean that there is not the opportunity for engineering in agriculture, but that the problems are more difficult. To suggest that the engineering related to agriculture is so elementary as to be non-existent either indicates a lack of understanding of the genius of engineering or it reveals a complete absence of imagination. Where there is so much labor, power, and materials there must be an opportunity for the engineer, and his work may be as difficult if not more so than that of many other branches of the profession.

A Significant Advance. Although agricultural engineering has not made such progress as those in this branch of the profession would have liked, there are some developments and achievements that may be pointed to with a degree of pride. There has been much engineering progress in agriculture, but the professional engineer has not made a large contribution. The proportion of man power required in agriculture, the production of food — a basic need — has become progressively less as the years have passed. In 1840 the agricultural workers were 77.5 per cent of the total; in 1900, 35.7 per cent, and in 1940 only 18.5 per cent. Now after two years of war it is estimated that only 16 per cent of our man power is used in agriculture. It would be presumptuous to claim that all of this change has been possible through the introduction of engineering methods, for increase in yields from improved varieties, the influence of better soil management, and more effective crop protection have contributed much, but all careful observers will agree that increased labor efficiency was the most important factor.

The industrial progress in the United States has been the outstanding event of the world's industrial history. It is true that we had a wealth of resources in materials, but it is also true that the man power came largely from agriculture. Do not let anyone assume with full assurance that industrial development came first and agricultural development followed. The reverse order of events may be as nearly accurate.

We are now engaged in a war that is testing our resources to the utmost. It is generally accepted that we have gained our present advantage through our ability to produce in quantity the equipment and munitions of war, but I would like also to remind you that no country in the wide world could spare so much man power from its agriculture as the United States, and at the same time increase production. In my home state there are about 200,000 farms. These are individual farms — family farms with the largest annual income per farmer among the states. A recent estimate credits these farms with furnishing 190,000 men to the armed forces and to munitions manufacture. If we have the wit and wisdom to go forward after this war and continue to increase through engineering our services and commodities to human society, additional man power will be available from agriculture, because all of its prewar requirement will not be needed. But the particular point is that, largely through the application of engineering techniques, agriculture has made its contribution to the war effort.

Russia's National Defense. The Russian people have made a magnificent defense of their homeland. They have repelled the invader, our common enemy, and history may record that through them the world was saved from despotism.

All liberal-minded observers will agree that this tremendous war effort upon the part of the Russians had its genesis in the application of engineering techniques to their agriculture, the mechanization of their agriculture as they called it. Under the old regime in Russia about 85 per cent of their population was on the land. Very primitive methods prevailed and often there were famines. The other 15 per cent of the population was divided between the nobility and those in commerce and in the trades. Those responsible for the first five-year plan foresaw that, if they were to develop industrially and otherwise, man power had to be made available from their agriculture. So they embraced our agricultural methods — our more extensive methods, in fact. Some of us were glad to have a small part in the program in 1929. To be an engineer in Russia at that time was to command respect. To be an American engineer was to be esteemed, and to be an American agricultural engineer was to hold a place of special honor. It was out of this program of agricultural engineering that the Russians secured the man power for their manufacturing industires, for their transportation, for their new educational program, for their armed forces. When the story of Russia's war effort is properly written into the pages of history, the influence of the introduction of agricultural engineering must be given a prominent place as a background.

The Future. And now I would like to direct your attention to the future. It is the worthy ambition of the engineer to produce commodities which will contribute to human well-being, in other words, to making the world a better, a more comfortable, a more healthful and interesting place to live. To some of us the opportunity seems particularly inviting to the agricultural engineer. The possibilities for advancing labor efficiency in agriculture are still very great. We are rapidly substituting the world's lightest prime mover, the internal-combustion engine, for the heaviest prime mover, the animal, and we have been largely devoid of imagination. We have been trying to make a mechanical horse — a pulling unit — out of the engine instead of capitalizing its great advantage, lightness. Housing—the housing of farm *(Continued on page 478)*

Agricultural Engineering and Engineering Education

ENGINEERING educators are becoming increasingly interested in the field of agricultural engineering. The pressing need for better engineering in the agriculture of all countries of the world is becoming more and more evident.

At the agricultural engineering conference held during the 52nd annual meeting of the Society for the Promotion of Engineering Education at Cincinnati in June 1944, Dr. J. B. Davidson, head of the agricultural engineering department of Iowa State College, frequently referred to as the dean of agricultural engineering educators in this country, presented the accompanying paper in which he defines the field of agricultural engineering, describes accomplishments, and points out future trends. Dr. Davidson feels that all engineers should be interested in the proper development of this branch of the engineering profession which is so closely related to perhaps the most fundamental activity of mankind, the production of food.

A problem facing agricultural engineering educators in many colleges and universities, as well as members of accrediting committees of the E.C.P.D. (Engineers' Council for Professional Development), is that of accrediting curriculums in agricultural engineering. R. A. Seaton, dean of engineering of Kansas State College, presented at this same S.P.E.E. conference a most complete and thought-provoking paper on accrediting of agricultural engineering curriculums, also printed in this issue. He concludes his paper with a general specification of the type of agricultural engineering curriculum which he believes would fully merit accreditation by E.C.P.D.

This conference on agricultural engineering was attended by twelve heads of agricultural engineering departments from various state colleges and universities; Dr. H. T. Heald and Dr. D. B. Prentice representing E.C.P.D.; Professor R. H. Driftmier, president, A.S.A.E.; engineering deans, and agricultural engineers engaged in industrial work.

Considerable discussion followed the presentation of the two papers. All agreed that much benefit would result from continuing agricultural engineering conferences at S.P.E.E. meetings looking toward further clarification of accrediting curriculums and other matters related to agricultural engineering, of common interest to all engineering educators.

L. J. FLETCHER

Chairman of Agricultural Engineering Conference at S.P.E.E. Annual Meeting

Accrediting of Agricultural Engineering Curriculums

By R. A. Seaton

IN CONSIDERING the subject of accrediting agricultural engineering curriculums, or any other engineering curriculums for that matter, it is important to keep in mind the circumstances that give rise to the need for such accrediting.

Perhaps the most compelling of these circumstances was the general enactment, within the past two or three decades, of state laws providing for the registration or licensing of professional engineers. These laws and their requirements are intended "to safeguard life, health, and property, and to promote the public welfare."[1] They follow to some extent the patterns established for the licensing of doctors, lawyers, and other groups of practitioners. Because they are state laws, a separate board is required in each state having such a law. These boards are charged with the responsibility of passing upon the qualifications of applicants for engineering registration in their respective states, and therefore have to set up minimum standards of training and experience in conformity with the requirements of the registration laws. These laws differ considerably in the several states, but in most or all of them one of the alternative criteria prescribed for qualifications for registration includes "graduation in an *approved curriculum* of four years or more from a school or college *approved by the Board* as of satisfactory standing".[2] Each engineering registration board therefore is required by law to be an accrediting agency for engineering curriculums and engineering schools whose graduates seek registration in its state.

Likewise most or all of the national, state, and local engineering societies have criteria for qualifications for membership in one or more grades which involve the matter of graduation from an *approved school or curriculum.* The U. S. Civil Service, other federal, state, and local governmental agencies, and many industrial corporations and individual employers use similar criteria for employment or advancement of their employees.

To have all of these boards, societies, governmental agencies and employers proceeding independently to obtain data on and to evaluate the work done in the several curriculums of the many engineering schools would be unthinkable. Obviously it was necessary for a national group of high standing to prepare an authoritative list of accredited engineering curriculums upon the basis of adequate data, intelligently and impartially evaluated. No such list could be expected to be perfect because of human fallibility and border line situations, but if the work were well done the result might well be expected to be better than could be secured in any other manner.

The difficult task of accrediting engineering curriculums was undertaken in 1935 by the Engineers' Council for Professional Development through its Committee on Engineering Schools and was substantially completed in 1939. Minor revisions have been made annually since that time. Much credit is due to the Council, and especially to its committee, for the workmanlike manner in which the job was done. That the result was generally satisfactory is attested by the wide acceptance of the E.C.P.D. "List of Accredited Undergraduate Curricula". It is now used generally, as published or with minor variations, by most registration boards and other groups concerned with the matter of approved curriculums.

Of *eleven* curriculums in agricultural engineering submitted to E.C.P.D. for evaluation up to 1943, *three* were fully accredited and *eight* were not accredited. In addition, *one* agricultural engineering option in an accredited mechanical engineering curriculum is noted in the E.C.P.D. list. If this option in mechanical engineering be considered as equivalent to an accredited agricultural engineering curriculum, the totals become four accredited and eight not accredited, or a ratio of 1 to 2. Numerous other agricultural engineering curriculums have not been submitted to E.C.P.D., perhaps because the schools had no hope of securing favorable action, so the ratio of accredited to total non-accredited curriculums in this field is extremely small.

This is not a situation that should be permitted to continue. It is unwholesome for both the schools and the engineering profession for a large percentage of the agricultural engineering curriculums offered by the leading schools of our country not to be accredited. It is unfair to the graduates of these curriculums and to the schools offering them. It tends to bring into question the validity of the standards and criteria of the accrediting agency and to bring agricultural engineering into disrepute as a branch of the engineering profession. If the fault lies with the curriculums, they should be either strengthened or discontinued. If the fault lies with the accreditation criteria and standards, these should be changed. If both the curriculums and the accreditation are at fault, both should be remedied as promptly as possible in the interests of all concerned.

The E.C.P.D. and its Committee on Engineering Schools have undertaken the accrediting of only those professional curriculums in engineering that are worthy of recognition as such. Obviously then, agricultural engineering curriculums should be accredited by E.C.P.D. only if they are truly *professional* and are really curriculums in *engineering.* If they are not *engineering* curriculums, but are rather curriculums in *mechanized agriculture,* or if they are *subprofessional* in character, as technical institute curriculums are subprofessional, they should not be accredited as professional engineering curriculums, no matter how important their function may be or how high may be the standards and quality of instruction. The very name of agricultural engineering would in this case be inappropriate and should not be used.

If the agricultural engineering curriculum, courses, staff, students, and budgets are administered solely or chiefly in the college or school or division of agriculture under a dean who knows little or nothing of engineering principles and of the engineering method, or if most of the departmental staff members are not themselves professional engineers, however competent they may be in other fields of endeavor, it is too much to expect that students in the curriculum will develop professional engineering competence.

If suitable mathematical, scientific, and technical prerequisites are not required for advanced courses, or if agricultural or other students without such prerequisites are admitted to the same technical classes as the professional students in agricultural engineering, then suitable standards and quality of instruction cannot be maintained, however competent the staff and administration may be, and the curriculum is not worthy of recognition as a professional curriculum in engineering.

If the curriculum covers only such engineering fundamentals as are required in the first three years of other engineering curriculums and the remainder of the time is devoted to elementary agricultural courses and specialized agricultural engineering courses in which the use and application of the engineering fundamentals of the first three years are not required, but which are chiefly descriptive of equipment and techniques, the curriculum falls short of being truly a professional curriculum in engineering and should not be accredited.

Such deficiencies, actually found in many of the agricultural engineering curriculums submitted to E.C.P.D. for evaluation, were, I believe, the chief reasons why more were not accredited. Perhaps it may be interesting and worth while to review briefly a few reports of the E.C.P.D. inspecting committees without mentioning names of institutions or personnel. These reports were intended to reflect both the strong and weak points of the curriculums for the guidance of the regional committees and the main Committee on Engineering Schools in determining whether or not to recommend accrediting of the curriculums. They were supplemented by statistical data and reports upon supporting departments (omitted from this presentation). Following are three of these reports:

* * * * *

REPORT OF INSPECTION OF ..... COLLEGE

RE: *Agricultural Engineering*

1 The department was reviewed with Professor ....., head, and Instructor ..... Mr. ....., student assis-

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[1] A Model Law for the Registration of Professional Engineers and Land Surveyors, etc., Section 1.

[2] Ibid, Section 12, (1)a.

tant, was met, and the administration of the department was discussed briefly with Dean ..... of the Division of Agriculture, and Dean ..... of the Division of Engineering.

2 The curriculum, the courses, the staff, the students, and the budget are all administered in the Division of Agriculture, and are wholly independent of the Division of Engineering. About half of the course enrollments (except in Forge Shop, which is taken by all engineering students) are of agricultural engineering students and the remainder are of students in other agricultural curricula. No friction appears to exist because of the administrative arrangements.

3 Both Professor ..... and Mr. ..... hold B. S. degrees in agricultural engineering from ..... College, and both are graduates of state normal schools. Neither has had any graduate work. Both are members of the American Society of Agricultural Engineers.

Professor ..... has had several years experience as extension specialist in agricultural engineering and director of the rural electrification study in ..... He also served for several years as engineering editor of the ..... Farmer. He is author or joint author of numerous extension circulars and agricultural experiment station bulletins dealing with agricultural engineering subjects.

Mr. ..... worked one year for the Ford Motor Company, ... branch, and was engaged in electrical equipment sales several years. He is joint author of three agricultural experiment station bulletins.

Mr. ..... holds the degree, B. S. in agriculture from ..... College and expects to complete the requirements for his B. S. in agricultural engineering next year. He has had several years experience as district 4-H club agent in the college extension service.

The two shop instructors appear to be well qualified for their work. Assistant Professor ..... of the wood shop is a graduate of ..... Institute, and Instructor ..... of the forge shop has a B. S. degree from ..... College and is a certified arc welder.

4 Relatively little of the students' time is devoted to recitations, most of the courses (except shop courses) consisting of one credit hour of recitation and two credit hours of laboratory work. The laboratory work in general appears to be of a character more suited to the training of an operator or mechanic than of an engineer. Agricultural students as well as agricultural engineering students are admitted to the courses general mechanics, farm machinery, farm motors, farm structures (first course), drainage engineering, and farm and home utilities, which indicates the elementary and non-technical character of these courses. Follow-up courses are provided in advanced farm motors and power, farm structures (second course), and land improvements and drainage, to which non-agricultural engineering students are not admitted, except by special permission, for the courses are too technical for such students, but even these courses do not appear to be of really high-grade engineering character.

5 The curriculum includes the same courses in mathematics, inorganic chemistry, physics, economics, forge shop, engineering problems, mechanics and materials, and hydraulics that are taken by other engineering students, the same electrical machinery that is taken by civil engineering students and the same surveying that is taken by electrical and mechanical engineering students, plus a little engineering and architectural drawing, topographic surveying, quantitative analysis and machine shop. It also contains an option of heat engines or mechanical laboratory and descriptive geometry. Little else of an engineering or scientific character is required, except the departmental courses mentioned in paragraph 4 above, though 15 term hours of elective, which may or may not be in engineering or science, are provided.

6 The textbooks used are believed to be suitable, though too little time seems to be devoted to them, as noted in paragraph 4 above. Laboratory direction sheets examined were considered to be only fairly well prepared.

7 Enrollment is increasing fairly rapidly, having grown from 6 in 1929-30 to 28 in 1934-35, and to 41 in 1936-37. The total number of graduates to date is estimated at 20 to 24. Graduates were reported to be well placed, largely in soil conservation work. Several were reported to be engaged in farm machinery sales work.

8 The quarters of the department are not very satisfactory but will be improved somewhat by an addition now under construction by WPA labor. Equipment is mostly loaned by the manufacturers, except that used inthe shop courses. The shops of the department were not examined by myself, but were reported to me by another member of our committee as being well housed and well equipped.

9 The quality of the student laboratory reports examined appeared to be only fair. Some student drawings of farm structures were good. Final examination questions examined indicated that the courses are "practical" rather than technical.

10 No graduate work is offered except that graduate students in agriculture majors may take some of the agricultural engineering courses as graduate minors.

Four agricultural engineering research projects are under way.

11 Because of the facts that:

(a) the administration of the staff, the courses, the curriculum, and the students is in the Division of Agriculture instead of in the Division of Engineering;

(b) the agricultural engineering courses do not appear to contain sufficient real engineering work of appropriate quality; and

(c) the amount of other engineering in the curriculum is not considered sufficient to compensate for this deficiency;

it is recommended that the curriculum be not accredited.

February 25, 1937 (Signed) .....

* * * * *

REPORT ON INSPECTION OF ..... COLLEGE

RE: *Agricultural Engineering*

1 The department was reviewed on February 17-18, 1937, by ..... and ..... A conference was held with ....., head of the department; ....., instructor; and ....., graduate assistant.

2 *Organization.* The curriculum in agricultural engineering is listed in the School of Engineering and its administration as a curriculum is under the supervision of the Dean of Engineering. The list of courses offered and the faculty of the department of agricultural engineering are listed both under the School of Agriculture and the School of Engineering. The administration of the department is wholly in the School of Agriculture, salaries and operating funds being allocated through that school and selection of staff and all routine matters relating to the department being handled through the Dean of Agriculture.

The members of the departmental staff also constitute the staff of the agricultural engineering division of the agricultural experiment station.

3 *Staff.* The staff is not impressive. The head of the department holds the B. S. in agriculture, followed by a corresponding degree in engineering. No member of the staff has received the master's degree, though both the instructor and the graduate assistant have done some work toward that degree.

The head of the department reports membership in the American Society of Agricultural Engineers.

4 *Plan of Instruction.* Instruction appears to be largely by lecture and class discussion method. The courses offered in agricultural engineering are predominantly practice courses. Of the nine offered, four include no theory, three have one hour of theory, and two each have two hours. Very few examples of student work were available for inspection, but judging from the few examples submitted the work is of a rather elementary nature.

The courses are given without prerequisites and all of them are offered as service courses to agricultural students who have been required to take no mathematics or other preparatory courses.

5 *Curriculum and Options.* The curriculum includes the mathematics through calculus and the physical sciences required of other engineering students. It includes mechanics, strength of materials, and hydraulics. In addition the courses in steam power plants, steam laboratory, machine design and electrical engineering are identical with those required for electrical engineering students. To the extent that the curriculum includes a general foundation of engineering subjects, it is satisfactory, but the courses in agricultural engineering apparently make no use of these courses, nor can they when they are open freely to students who have had none of the courses which might properly be required as prerequisites. The required courses in agriculture are those usually considered necessary in this curriculum and do not absorb an undue portion of the time.

6 *Textbooks.* Course 202, now known as "Elements of Engineering" but soon to be called "Soil Conservation", is the only course in the department for which a text is required. This uses a text prepared by members of the department staff. The statement was made that the courses were kept flexible to fit the needs of the students, but there was apparently a lack of any definite organization in the instruction.

7 *Enrollment.* The enrollment in the agricultural engineering curriculum has increased from 10 in 1929-30 to 26 in 1935-36, and 32 at present.

8 *Facilities.* The agricultural engineering building was erected in 1910 as a livestock judging building. The office, farm machinery laboratory and some classroom facilities are provided in it, but classes are also held in other buildings as needed, and much of the farm machinery is housed on the experimental farm. Some additional building space has been promised by WPA. As is frequently

the case in other colleges, much of the farm machinery is loaned by manufacturers and is replaced with modern units as it becomes obsolete. Those laboratories in which the equipment has been purchased by the institution seem inadequately equipped.

9 *Quality of Student Work.* Has been discussed under paragraph 4 opposite.

10 *Graduate Work and Research.* Little organized graduate work was in evidence, though some was undoubtedly being conducted in connection with the agricultural experiment station.

11 *Conclusions and Recommendations.* Although the basic instruction in mathematics, physics, mechanics, and general engineering subjects meet the requirements of an engineering course, the courses in agricultural engineering are inadequate. While theoretically there is joint control by the Deans of Engineering and of Agriculture, the Dean of Engineering apparently lacks sufficient authority over the department and its personnel to insure the course meeting adequate standards. For these reasons and because the courses are given without use of prerequisites and without proper rigidity of standards, as well as for other reasons discussed more fully above, it is recommended that the curriculum in agricultural engineering be not accredited.

(Signed) .....

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REPORT OF INSPECTION OF ..... UNIVERSITY

RE: *Agricultural Engineering*

1 The department was reviewed with Professor ....., chairman. Professor ..... participated in some of the discussions and laboratory inspections. Brief contacts were made with Professor ..... and Dean ..... of the College of Agriculture. Administration of the department, the students and the curriculum was discussed with Acting Dean ..... of the College of Engineering.

2 The department is administered in the College of Agriculture. It was organized in 1914 as a service department for agricultural students, and still serves chiefly in that capacity. Nearly all of the courses are open to agricultural students, with only a few elementary prerequisites or none at all. Even the courses listed "For Advanced Undergraduates and Graduates" have no more advanced prerequisites than ten quarter credit hours of mathematics *or* physics, and certain elementary courses in agronomy, animal husbandry, and agricultural engineering. The elementary and "practical" character of the courses is evident from this lack of scientific and technical prerequisites.

Certain courses of the department are required in some of the agricultural curricula and many of the courses are suggested as acceptable electives in these curricula. In addition, a major in agricultural engineering is offered in the four-year curriculum in general agriculture. Ninety-eight students are now enrolled in this major.

The curriculum submitted for appraisal was organized in 1934 and is called the "Professional Curriculum in Agricultural Engineering". It includes five years of work, the first four of which are administered in the College of Agriculture and lead to the degree of bachelor of science in agriculture. The fifth year is supposed to be administered in the College of Engineering and leads to the degree of bachelor of agricultural engineering. Only one student has yet completed the fifth year, and he was graduated at the end of the first quarter of the present academic year. One more student is expected to graduate at the end of the present quarter, and three more at the end of next quarter. Fifteen other students are registered in the curriculum, mostly in the first and second years. These students are handled in the same classes as those taking the agricultural engineering major of the curriculum in agriculture and other agricultural students taking the courses as required or elective work.

While the entire fifth year is supposed to be administered in the College of Engineering, as noted above, the one student that has been graduated was registered for only one quarter in the College of Engineering, and only two of the four present fifth-year men had registered in the College of Engineering at the time of the inspection. The system is evidently not yet working as planned.

3 The staff consists of Professors ....., ..., and ....., each of whom is supposed to devote three-fourths of his time to instruction and one-fourth to research, and Professor ....., who is supposed to devote one-eight of his time to instruction and seven-eighths to extension activities. Actually the teaching loads occupy more of the time, running from 18 to 20 clock hours for the first three men and 14 clock hours for the fourth. Some classes are much too large, including about 50 students under one professor in both recitation and laboratory work.

Professors ....., ..., and ..... all hold the degree of Bachelor of Science in agriculture, and Professor ..... has the degree of bachelor of science in agricultural engineering. No staff member has an advanced degree. Professor ..... spent three years as a student in mechanical engineering at the University of ..... before changing to the agricultural curriculum.

Most of the staff members have had good industrial experience, have written extensively for publication, and have been active in the American Society of Agricultural Engineers. No membership in any other engineering, scientific, or educational society was reported.

4 Instruction follows the usual plan, except that rather more of the time appears to be devoted to class room discussion (not recitation), to inspirational and philosophical teaching, and to economic considerations, and less to technical subject matter than is usual. For the most part, no textbooks are used because the professors believe (a) there are no suitable texts available, (b) rapid changes in design and use of farm machinery would quickly make texts obsolete, and (c) (quoting from a report by Professor .....) "Also we do not favor texts, as such, for general use, because we are more interested in improved educational methods of guiding students to gain information by their own thought process in lieu of giving it to them for memorization". Extensive use is made of mimeographed instruction sheets and home problems, which seem to be fairly well prepared for service courses for agricultural students.

5 The curriculum includes as required work all of the courses of the common freshman year for engineering students, except qualitative analysis. It also includes ten of the same fifteen quarter credit hours of calculus, and the same physics, statics, strength of materials, dynamics, English and economics required of mechanical engineering students. No mechanisms, hydraulics, thermodynamics, heat-power engineering, or electrical engineering, no civil engineering except 3 to 5 hours of surveying and no industrial engineering except 3 hours of machine shop work, are listed as required courses, though such courses are available as electives and 50 to 60 hours of engineering electives are to be taken.

All the fifth-year work except three quarter credit hours is elective, 30 hours being listed as engineering elective, 3 to 15 hours as agricultural engineering special problems, and the remainder as open elective. Of the fourth-year work 20 to 30 hours are listed as engineering elective, and 5 to 15 hours as agricultural elective. Thus about three-fourths of the last two years' work are elective, subject to the approval of the chairman of the department. Groups of engineering electives are suggested for students wishing to specialize in (a) land maintenance and improvement, (b) farm structures, (c) farm power and machinery, or (d) rural electrification.

While 50 to 60 hours of engineering elective are scheduled in the curriculum, only 33 hours of engineering elective were reported as actually having been taken by the student graduated last fall, and 37 hours by the student who is expected to graduate at the end of the present semester. Neither of these students followed any one of the groups listed above.

6 Such texts as are used are considered suitable, but, as noted under (4) above, few are used. Laboratory direction sheets are considered fairly satisfactory.

7 For enrollment data see (2) above.

8 The building and equipment are considered fully adequate — much better than are usually found. Housekeeping is good. A good agricultural engineering library is housed in the building. Maintenance funds are low at present, but this condition is considered temporary.

9 Little student work was available for inspection. That examined was considered of fair quality of its kind but reflected the lack of real engineering training.

10 The staff is doing a fair amount of creditable research and numerous publications have been issued based wholly or in part upon the research work done in the past.

11 The principal unsatisfactory situations noted in agricultural engineering may be summarized as follows:

(a) The curriculum is comparatively new and the policies and procedures are not well established.

(b) Insufficient administrative authority and responsibility are vested in the College of Engineering.

(c) Only one of the four staff members has an engineering degree and no staff member has an advanced degree.

(d) The courses are too elementary and non-technical in character, the prerequisites being inadequate and engineering and non-engineering students being handled in the same classes.

(e) Insufficient basic engineering instruction is included in the required courses of the curriculum,

(f) The number of elective hours is so great that the curriculum is highly indefinite.

Because of these conditions it is recommended that the curriculum be not accredited.

March 22, 1937 (Signed) .....

Would you have recommended any of these three curriculums for accrediting? Do you believe that students in these curriculums could be expected to receive adequate training for the practice of professional engineering as defined in the Model Registration Law? That definition is as follows: "The practice of professional engineering within the meaning and intent of this Act includes any professional service, such as consultation, investigation, evaluation, planning, design, or operation, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects, wherein the public welfare, or the safeguarding of life, health, or property is concerned or involved, when such professional service requires the application of engineering principles and data." Would engineering registration boards, appointed to administer laws designed "to safeguard life, health, and property, and to promote the public welfare" be justified in classing these three and other similar curriculums as approved curriculums in engineering? I think not.

What should agricultural engineering educators and administrators do about this situation? I believe that now, while enrollments are at a low ebb, all agricultural engineering curriculums, courses, departmental organizations and staffs, as well as all these same items in all other fields of education, should undergo careful analysis and thorough study. Such changes should be made as may be found necessary to accomplish most surely and efficiently the desired objectives.

Service courses for agricultural students should undoubtedly continue to be given by the department of agricultural engineering. These courses should be planned and taught in close cooperation with the agricultural faculty and should be designed to be of the greatest value to the *agricultural* students they serve.

Perhaps an option in mechanized agriculture should be offered in the agricultural curriculum and administered under direction of the dean of agriculture. This should not be titled as a curriculum in agricultural engineering or an option in agricultural engineering.

In addition, I believe there is real need, in a moderate number of institutions, for a truly professional curriculum in agricultural engineering of such character as to merit fully accreditation by E.C.P.D. My idea of these curriculums is as follows:

1 The curriculums should carry about the same content in physics, chemistry, mathematics, mechanics, and perhaps thermodynamics as the curriculums in other major branches of engineering.

2 The content of agricultural subjects should not exceed about 12 or 15 semester credits.

3 The recitation, shop and laboratory courses in agricultural engineering for professional agricultural engineering students should require suitable prerequisites and be taught separately from those courses open to agricultural students without these prerequisites. All shop or laboratory courses should be organized to teach principles rather than mere practice or manual skill.

(Continued on page 478)

An Agricultural Engineering Curriculum

THE Committee on Curriculums of the American Society of Agricultural Engineers feels that, while basically agricultural engineering educators are not far apart as far as fundamentals are concerned, they apparently have not achieved agreement as to just what should constitute a standard curriculum in agricultural engineering. The Committee offers for the consideration of these educators the following curriculum which, though not a standard curriculum, is approximately representative of the three curriculums that have been approved by E.C.P.D. These curriculums, however, were prewar curriculums and many changes and improvements in them are being planned for the postwar period.

A SUGGESTED AGRICULTURAL ENGINEERING CURRICULUM

FRESHMAN YEAR	Semester hours
First Semester	
Chemistry, general chemistry	4
English, composition	3
Mathematics, college algebra	3
Mathematics, trigonometry	3
Drawing, mechanical drawing	2
Shop, foundry production	1
Military science, artillery	1
	17
Second Semester	
Chemistry, chemistry of metals	4
English, rhetoric	3
Mathematics, analytical geometry	4
A. E., elements of agricultural engineering	2
Drawing, descriptive geometry	2
Shop, heat treating and welding	1
Military science, artillery	1
	17
SOPHOMORE YEAR	
First Semester	
Physics, engineering physics	5
Mathematics, calculus	5
Mechanical drawing	2
C. E. surveying	2
Public speaking	5
Metallurgy	2
Military science, artillery	1
A. E., seminar	R
	18
Second Semester	
Physics, engineering physics	5
Mathematics, calculus	4
Economics	3
C. E., surveying	2
Machine design, mechanisms	3
Military science, artillery	1
A. E., seminar	R
	18
JUNIOR YEAR	
First Semester	
Applied mechanics, statics	4
M. E., thermodynamics	4
A. E., farm machinery	4
Agronomy, farm crops	3
Geology, general geology	3
A. E., seminar	1
	18
Second Semester	
Strength of materials	5
A. E., farm motors	4
Agronomy, soils	5
Agrl. economics, farm management	3
A. E., seminar	R
	18
SENIOR YEAR	
First Semester	
A. E., farm structures design	4
Hydraulics or fluid mechanics	4
C. E., highway engineering	2
E. E., electrical engineering	3
Electives or options	4
A. E., seminar	R
	17
Second Semester	
A. E., soil and water conservation	4
Business law, contracts, or report writing	3
A. E., farm and home equipment	4
Electives or options	5
A. E., seminar	1
	17

Total, 140 semester credits

CONTENT OF AN AGRICULTURAL ENGINEERING CURRICULUM

The following subject matter content of an agricultural engineering curriculum has been divided into eight different divisions which should prove helpful in considering the curriculum problem.

	Semester credits
1 Basic science, mathematics, chemistry, physics	36
2 Basic engineering subjects	33
3 Applied agricultural science	15
4 Agricultural engineering subjects	22
5 Groups or options in one of four fields	9
(a) Mechanical subjects	
(b) Soil and water conservation	
(c) Structures or	
(d) Electrical subjects	
6 Humanistic or general subjects	12
7 Military	4
8 Elective	5
	136

Gypsum Board in Farm Building Construction

By Henry J. Schweim

ASSOCIATE A.S.A.E.

NATURAL gypsum is a rock that is either mined or quarried depending upon the location of the strata with reference to the surface of the ground. It is mined or quarried in relatively large pieces, and is broken to what is termed one-man size and conveyed to the head house where it passes through the first of two stages of crushing. The first crusher reduces it so that it will all pass through a 5-in ring, and the secondary crusher from dust to about ⅜ in.

The conversion of gypsum to calcined gypsum, or plaster of paris, is through calcination, a process of dehydrating or removing a large part of the chemically combined water. Gypsum is known chemically as hydrous calcium sulfate. It is composed of one part of calcium sulfate and two parts of water; hence, its chemical formula is $CaSO_4 \cdot 2H_2O$. What calcination does is to remove approximately one and one-half parts of water, leaving $CaSO_4 \cdot \frac{1}{2}H_2O$, which is the hemihydrate known as calcined gypsum or plaster of paris. This is the basis of all gypsum building products.

When water is added to calcined gypsum, the gypsum takes up or combines with the same amount of water that was driven off in the calcination process. In other words, it reverts to gypsum, $CaSO_4 \cdot 2H_2O$.

There is gypsum in abundance in this country. Gypsum mines and mills are located in sixteen states. In addition, gypsum is shipped into some half dozen other states to gypsum mills where it is manufactured into gypsum products. These mills are located in some of our larger cities.

One of the main advantages of gypsum is that it is fireproof. It will not burn and it will not add fuel to the fire. Gypsum is unique as a fire-protective material in that it does not require excessive mass or weight to provide appreciable fire protection. As stated, gypsum is composed of one part of calcium sulfate and two parts of water, and when it is attacked by fire, it releases or gives off the chemically combined water, and as it is impossible to heat water above 212 F, so is it impossible to heat gypsum above this temperature until all the chemically combined water has been driven off. This, however, is a long, slow process. As the chemically combined water is evaporated, the calcined gypsum thus formed does not fall away but remains in place, acting as an insulator, thus protecting the uncalcined gypsum. Therefore, the rate of calcination is not proportional to time but proceeds more and more slowly as time goes on.

Fire resistance or fire protection is inherent in every gypsum product regardless of thickness. Naturally the greater the thickness, the greater the fire protection. For example, a wood stud partition covered on each side with ⅜-in gypsum wallboard has a fire resistance rating of 25 min. Substituting ½-in gypsum wallboard for the ⅜-in board, the fire resistance is increased to 40 min, and using ⅜-in perforated gypsum lath plus ½ in of gypsum plaster on each side of wood studs provides a construction that has a one-hour rating, tested in accordance with the ASA Standard Specifications for Fire Tests.

This matter of fire protection is always important in all places but particularly on the farm. Most farm buildings are not within easy reach of public fire-fighting equipment; therefore, it behooves every farm owner to provide effective safeguards against the starting and spreading of fire. The proper use of incombustible materials such as gypsum board products as a fire protection to the combustible supports to which they are applied will materially reduce our annual farm fire loss. The fire loss on farms is estimated as $100,000,000 in property and 3500 lives annually.

Gypsum boards are not new. This year we celebrate the fiftieth anniversary of the development of gypsum board. One of the first gypsum boards on the market was, in a sense, a laminated board, it being composed of three layers of gypsum and four alternate layers of wool felt paper. It was first used in New York in 1894 and was known as Sackett board. It was the forerunner of the present gypsum lath. Eighteen years later, or about 1912, gypsum wallboard was developed, and in 1925 gypsum sheathing board was introduced. All these boards were used on the interior of buildings, or if on the exterior were protected from the weather with wood siding, stucco, or brick veneer.

With the shortage of lumber and the demand for material to take its place, laminated gypsum board was developed for short span roof decks and exterior siding.

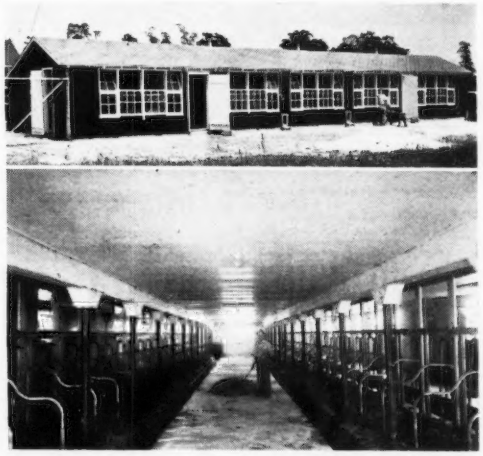
Laminated gypsum board roof decks are composed of separate layers of ½-in gypsum board laminated with a water-resistant adhesive into a solid unit 2 ft wide and up to 10 ft in length. These units are available in three thicknesses — 1, 1½, and 2 in. The long edges on the 1-in and 2-in units are shiplapped, and on the 1½-in units these edges are either tongued and grooved or shiplapped. They are erected with the long edges at right angles to supports and so placed that the butt edges bear on a support. The 1-in, 1½-in, and 2-in units are nailed to wood supports with 8d, 10d, and 16d nails, respectively, spaced 5½ to 6 in apart. The industry recommends a spacing of supports of 16 in for 1-in units, 24 in for 1½-in units, and 36 in for the 2-in units. However, for sheds, brooder houses, poultry houses, etc., ½-in gypsum sheathing board is being used for roof decks, spanning from rafter to rafter where the spacing of the rafters does not exceed 18 in on centers. However, this roof sheathing is not designed to carry concentrated loads such as the weight of a man. Temporary foot scaffolds or planks must be employed during erection of such sheathing and roof covering. Normally, ½-in gypsum sheathing board used as roof sheathing is applied to wood nailing strips, the spacing and size of strips being dependent upon the type of roof covering employed.

The Gypsum Association has prepared specifications covering the application of shingles, built-up roofing, roll roofing, and 19-in selvage-edge roofing to laminated gypsum board roof decks.

Gypsum exterior board or siding is manufactured in two thicknesses, namely, single sheets ½-in thick, or laminated units consisting of two sheets of ½-in board laminated with a water-resistant adhesive into a solid board 2 ft wide and up to 10 ft in length. The long edges of the laminated board are shiplapped and the ends are flush or square.

Gypsum board for siding is available plain, that is, without any weather-resistant covering other than the paper on the face of the board, or it may be had with the surfaces, edges, and ends weatherproofed at the mill or with the weather side faced with asphalt roll roofing, either smooth or mineral surfaced.

When the plain gypsum board is used for siding, it should be painted with two coats of oil paint after erection. The material weatherproofed at the mill has the surfaces, edges, and ends sealed with a water-resistant material and requires no further treatment on the job. However, as this



These two views show use of gypsum board for the walls of a poultry house (top) and for ceiling of a dairy stable (bottom)

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis., June. 1944, as a contribution of the Farm Structures Division.

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treatment weathers it penetrates further into the core of the board; thus in time it can and should be painted with an oil paint to maintain its weather resistance.

Gypsum board used as exterior wall covering may be erected with the long edges either at right angles or parallel to supports. In horizontal application all ends should be backed by wood members, and in vertical application both edges and ends should be backed by wood members. The ½-in board is applied with 5d or 6d cement-coated nails or 1¾-in galvanized roofing nails, and the 1-in board with 7d or 8d cement-coated nails or 2-in galvanized roofing nails. In both cases the nails are spaced 4 to 6 in on centers. The industry recommends caulking all end joints and joints between field-cut boards.

Gypsum board roof decks and exterior board may be used as outlined on all types of farm buildings. However, it is recommended that the board be kept a sufficient distance above the ground to prevent contact with wet soil.

Gypsum board may also be used on the interior of these houses but in some buildings because of humidity conditions, use, etc., certain precautions must be observed. In brooder houses, for example, asphalt paint should be applied to the interior board, or either a cement-asbestos board or a strip of mineral-surfaced roofing should be applied over the lower 16 to 18 in of the wall to prevent the chickens from pecking the board. If the house is not lined, the back of the exterior gypsum board should receive a heavy coat of asphalt paint extending 16 to 18 in up from the floor line. In poultry houses, it is recommended that this protection extend 24 in above the floor. In hog houses a permanent guard rail should be provided 10 to 12 in above the floor. In milk houses, dairy barns, and, in fact, in most buildings housing livestock, gypsum boards used on ceilings and the interior side of exterior walls should be given a coat of pigmented varnish primer and one or more coats of a good gloss oil paint. In such buildings it is also very important that full consideration be given to installation of adequate ventilation.

Because of the high relative humidities that prevail in potato storage buildings, it is necessary that an effective vapor-barrier be placed toward the warm side of the wall to prevent condensation from forming in the insulation or on the sheathing. With an effective vapor barrier, I see no reason that gypsum board cannot be used satisfactorily for the exterior wall covering and roof decks of these buildings.

We are now investigating the use of gypsum board in the construction of grain bins, and when this investigation has been completed, we will be ready to make recommendations for the use of gypsum board in such construction.

The Development of Agricultural Land for Irrigation Purposes

(Continued from page 470)

many older irrigated areas. When unit boundaries and county roads run parallel to irrigation ditches and natural drainage ways, the need for bridges is lessened. This makes possible a further reduction in the cost of county road service. Good project planning also permits more complete and economical service by rural power and telephone lines.

After all development work is completed, a plat of each farm unit is prepared which shows all physical and topographic features as illustrated in exhibit 5. As shown on this map, each farm is divided into fields. All permanent and seasonal ditches are located as well as the recommended direction of irrigation flow and the length of run best adapted to each field. The recommended type of irrigation best suited to different crops is also shown for each field. As a part of the development process, field boundaries, ditch locations, and the recommended direction of irrigation flow are staked out by a survey crew under the direction of a competent engineer. Throughout the land development job just as much consideration is given to future agricultural operations, farm management practices, and the type and use of agricultural machinery as is given to the water distribution system itself. Fields of proper size and shape allow for more economical operation of all types of farm equipment. Supervision and assistance in irrigation methods are made available to all operators on project lands.

In closing, attention is again called to the fact that land development as described in this paper covers only two types of projects of different basic physical characteristics. Nevertheless it is probably safe to declare that in any case a scientific job of land development pays dividens not only to the individual farmer involved but to society as well in terms of development and conservation of basic resources and in terms of expanded economic opportunity.

Accrediting Curriculums

(Continued from page 476)

4 The advanced work in power machinery, land reclamation and structures should be organized so as to include a considerable amount of application of the principles of the physical sciences, mechanics, machine design, thermodynamics, and the like, to the machines, structures, and operations peculiar to the agricultural engineering field and the manufacture of materials and equipment used in the agricultural industry.

5 The curriculum, the staff, and the students in agricultural engineering should be administered by the engineering dean. An alternative, but less desirable, method might be administration by a committee with the engineering dean as chairman. In any case, close cooperation should be maintained between the department of agricultural engineering and the several agricultural and engineering departments, not only in instructional matters but also in research and extension activities.

Any agricultural engineering curriculum so organized and administered, with a competent staff, an adequate budget, and high standards of instruction and accomplishment would, I believe, readily be accredited by E.C.P.D. Graduates of such a curriculum should find ready acceptance into the engineering profession and they should be well prepared to render very important services which are greatly needed by agriculture.

Agricultural Engineering

(Continued from page 472)

people, farm livestock, crops and equipment—is awaiting the combined contributions of the cooperative team, the scientist and the engineer.

We are engaged in the greatest contest of arms that the world has ever witnessed. Our objectives have been stated as a battle for freedom — freedom of speech, freedom of worship, freedom from fear, and freedom from want. The latter is not the least but it is for the most part freedom from famine. An interesting conference was held last year in the United States at Warm Springs, Virginia. It was the United Nations Conference upon Food and Nutrition. Two significant statements came out of the conference. The first was that two-thirds of the world's population were engaged directly in the production of food — 67 per cent against 18½ per cent in the United States. Second, that two-thirds, or an equal proportion, were continually hungry.

Who, may I ask, may have the opportunity to contribute the largest measure of service to the hungry world? I am not unmindful of other contributions that may be made, but if the world is to have more goods and services, engineering methods which enable more to be produced must be utilized. This week a representative of the Chinese Ministry of Agriculture addressed the agricultural engineers at Milwaukee. He estimated that something like 121 million acres of additional land could be brought into production. Some of this is marginal land which must be utilized on an extensive plan if at all.

It would appear to me that solving of the problem of freedom from want offers one of the greatest opportunities for service to humanity that ever came to any group of men, if it can but be grasped. I ask the engineering educators present, why not consider the soundness of what I am saying, and if you find it true, as I think you must, why not give the agricultural engineer encouragement?

There are a number of agricultural engineers present. I would say to you that we should embrace the unusual opportunity of service here and abroad. Engineers serve in the production of commodities and services, but the agricultural engineer serves in a most important way through the production of the most vital of the commodities the human race uses, food.

If these thoughts I have expressed have been of interest I am glad. If they may in any way enlist a greater interest among engineering educators, my reward is great.

Farm Electrification—A Challenge

By Frank E. Watts
ASSOCIATE A.S.A.E.

THE roots of farm electrification go deeply into the development of a sound agricultural economy of the future, and only in a limited way is the importance of agriculture on our national economy realized by industry, labor and the public in general. Exploration of this subject will soon make it evident that there cannot be full employment, production or prosperity in America unless agricultural income is maintained at a high level.

In our discussion the importance of farm income to our postwar problem number one — employment and production — will be stressed first. Second, how can farm income be maintained and increased in relation to total national income? And third, what can electric service contribute to this desirable end?

For several decades income of agriculture has approximated one-seventh, or 14 per cent, of our total national income. Against this, 23 per cent of our population is engaged in agriculture. Another 25 per cent, living in rural towns and villages of 2,500 population or less, is almost entirely dependent upon farmers for its livelihood.

In the final analysis markets for the products of industry, which employs labor, are people. If 23 per cent of our people have but 14 per cent of our national income, it is conceivable that unless farm income is raised to a higher percentage of total national income, we may have an unbalanced economy as a result of unbalanced purchasing power of this important segment of our population. This share of national income should approximate one-fifth of the total if it is to have the proper relationship to population measured in terms of purchasing power.

It is well recognized that agriculture, industry and labor are interdependent. If we are to have full employment in the postwar years for sustaining and supporting a national economy, which will pay heavy taxes, keep the nation prosperous and people happy, then we can have no unbalanced purchasing power between the three great forces affected.

Let us examine briefly the importance of farm income in employment and production. Out of a gross income of $2600 the urban worker had left in 1941 a spendable surplus after expenses for housing, household operations, food, income taxes, transportation to and from work, and recreation, approximately $1150. Out of every dollar of gross income he had left about 44 cents with which to buy services and other things, beyond those mentioned, which create employment. Out of the same gross income the farmer had left approximately $2000. His spendable surplus is greater primarily because he pays no rent; household expenses, income taxes and recreation are less and much of his food is grown on his farm. Out of every dollar of gross income the farmer has approximately 77 cents to spend for things which create employment and production.

The farmer's spendable surplus per capita is greater than the urban worker's and it therefore may be argued that he does not need as much income. However, we must not overlook this very important fact: where the urban worker has to buy only those things which contribute to his comfort, convenience or better standard of living, the farmer has to provide service buildings, new equipment and machinery and keep them in repair; buy fertilizer and other supplies necessary for the successful operation of his farm. This more than offsets his greater net income in relation to the urban worker.

But this is not the whole story in relation to employment and production; what the farmer spends his money for as compared to the urban worker has a most important bearing on this subject. Much of the urban worker's 44 cents is spent in restaurants, theaters and other forms of recreation which do not materially increase employment. On the other hand, practically every cent of the farmer's 77 cents is spent for things which directly increase employment and therefore production. This is particularly true as the income of each is increased. The urban worker who increases his income moves to a better house or apartment, he eats at better restaurants and more frequently; he goes to the theater more often, but none of these creates any additional labor. Expenses for household equipment for both may increase but the farmer's additional income, invested in things which make his farm more productive, far outweighs that of the urbanite in increased employment. When the farmer spends a dollar it turns over seven times in urban workers' hands. As a matter of fact, the value of a farmer's dollar is approximately 75 per cent greater in the most vital problem facing us — employment.

To emphasize further the importance of agriculture to some of our industries, the farm is the greatest market for zinc; annual purchases of steel for all purposes aggregate 12,000,000 tons in normal times — approximately one-seventh of our productive capacity. The chairman of the Producers' Council of the building industry estimates that one-third of the market for all light building construction after the war will be the farm. Investigation discloses that but 25 per cent of farms have a sufficient number of service buildings and that but 25 per cent of these are adequate for their intended use. "Wall Street Journal" on June 6th of this year estimated that farmers will invest from 2 to 2¼ billion dollars in farm electrification in approximately eighteen months after the war. These examples all stress the importance of farm purchases in the employment of labor by industry.

Farmers Have Money. Fortunately for American farmers they now have a greater accumulated spendable surplus than ever before in their history. As a result, they will be able to "catch up", as it were, with important developments which will favorably affect their business. In the past twenty years through scientific research and applications of mechanical and electric power as a substitute for muscle power, great progress is made possible in advancing productive efficiency. It is the farmer's dollar which will first prime the pump of prosperity.

It is a fallacy to believe that the farmer has been without money. The farm depression started in 1920 with the collapse of land values and lasted for 20 years. In this period farmers purchased over 4,000,000 trucks and automobiles and 2,000,000 tractors and electrified 1,750,000 farms as major expenditures. However, spendable surplus of farm income, which enables the farmer to buy equipment to produce by modern methods more economically and profitably, is an important factor in sustaining a sound agricultural economy. This theory of the relation of farm income to a balanced economy may be challenged on the ground that 20 per cent of people living on farms are negroes and illiterate whites whose income is barely one of subsistence, and that many small farms are not really farms at all. As a result, income of producing farms is much greater than shown by a national average. This does not alter the importance of *total farm income.* If this nation is to progress, more farms must be raised above a subsistence level by making them more productive and thus raising standards of living and purchasing power. Education, example and general progress will do this. The effect of a better agriculture will lift the whole general level, for agriculture can no more stand still than can industry. More productive family farms are of vital necessity. Large commercial farms will take care of themselves and point the way for smaller farms to increase production.

Basic Trends in Agriculture. The problem confronting agriculture in the future, therefore, is to maintain a higher proportionate spendable income through more efficient and profitable operation of a greater percentage of farms. Let us examine first the trends by which this desirable end may be attained.

There are four basic trends which are now putting farming on a firmer foundation of economical operation and greater production at less cost and therefore at greater profit. In the fulfillment of these trends lies the hope of agriculture in attaining a larger share of total national income.

First, the farmer is now securing a greater yield per acre of crops cultivated. This is being done through modern practices such as crop rotation which builds up the soil, more scientific fertilizing

An address before the annual meeting of the American Society of Agricultural Engineers, at Milwaukee, Wis., June, 1944, and before the North Atlantic Section of the Society, at New York, September, 1944.

FRANK E. WATTS is executive assistant, New York office, "The Farm Journal".

through better knowledge of the soil of individual farms, better crops resulting from seed testing, soil conservation by contour plowing and better methods of cultivation. There are other important developments in this direction but these are sufficient to illustrate this trend.

Second, new crops are being grown — crops which we formerly imported. The soybean is the greatest example of what can be done in such undertakings; it has been called the miracle crop. There are said to be one hundred and thirty agricultural products which we imported in the past, most of which can be grown in quantity at a profit in the United States. The war has emphasized how dependent we are for some of these essential products and we may expect considerable expansion in this field.

Third, the growth of products used in manufacturing industries and the utilization of more of the crops now grown. No part of many of our crops need longer be wasted. We have cigarette paper made from flax straw; substitutes for kapok from milkweed and cattails; plastics and essential oils from a score of farm products; alcohol from sweet potatoes. One of the latest discoveries — the production of gasoline from Louisiana sugar cane — may have a great effect on agriculture, especially in the South. These few examples illustrate a trend which will add greatly to farm income. The chemurgic movement was slow getting under way but is now established on a firm foundation, and we shall see still greater advances in the next decade.

Fourth, the processing or semiprocessing of crops on or near the farm is a movement now well under way. This assures better prices to the farmer, less waste in transportation, lower distribution costs, and therefore lower prices to consumers. It means a greater decentralization of industry, more people employed in rural areas, and a greater demand for electric power in these areas.

ONE THIRD OF POPULATION HAS "POOR" DIET

Is America Underfed? There is a fifth trend or force the effect of which on agriculture is somewhat unpredictable, but it cannot be other than helpful in increasing farm income. During the war we have learned much about the nutritive value of foods. More people, especially urban workers, have become conscious of these values. A comprehensive study by the Bureau of Home Economics of the U. S. Department of Agriculture of the nutritive quality of diets reveals some interesting facts. Diets are classed as "good", "fair", and "poor". The study reveals that more than one-third of our population has only a "poor" diet while more than another third is classed as "fair". We must come to the conclusion that in spite of our high standard of living we are not a well-fed nation. However, this is not always a result of a lack of "quantity" of food but selection of "quality" food. At a meeting in Chicago on May 29, 1944, George A. Sloan, president of Nutrition Foundation, Inc., said: "Out of research can come new industries, extensions of existing enterprise, advances in public health and continued improvement in conditions of living. We may look forward to the increased role of the scientist in guiding the policies of an expanding food industry in developing better processed and protected packaged foods." Certainly progress as here prophesied will result in an expanded agriculture. With our population better fed, we will have a greater consumption of such foods as milk, eggs, meats, fruits and vegetables—foods whose production lend themselves to greater electrification. The farmer will undoubtedly give more attention to growing "quality" foods which command a better price.

A Sound Agricultural Economy. There must be established in this nation a sound agricultural economy which has as its foundation the production of more goods for more people at less cost, *and at a profit.* This can never be attained by a "shot in the arm" or an aspirin tablet in the shape of subsidies frequently administered. Lower productive costs are a vital necessity to the farmers and speed in doing so is urgent — at this time when the danger of surpluses may be imminent. It may well be asked, "If we increase production, what will become of the surpluses which may be created?" It must be remembered that the foregoing enumerated "trends" are evolutionary and not revolutionary. The greater part of an increased agricultural income will not necessarily come from the production of foods, though this will have a great bearing as people are educated to better diets. The greater part of any increase will come from new and needed crops, from greater utilization of crops grown and new agricultural products used by industry, and from processing and semiprocessing on or near the farm.

The foregoing briefly illustrates trends which all those interested in a greater extension of electricity in agriculture must fully understand if an intelligent approach to market development is to be made. There is no greater force which will accelerate the trends in farming than electric service. It is not to be inferred that electricity is the only means of substituting mechanical for muscle power. The internal-combustion engine will do many of the jobs of an electric motor where electricity is not available. Washing machines and pumps are illustrations of the application of the gasoline motor. The great advantage of electricity is its convenience.

Electrification Accelerates Agricultural Trends. In approaching a study of farm electrification it will be helpful if we keep in mind the basic economic law that "labor is the source of the production of all wealth." Time is the measure of production of labor. Therefore any electrical application which conserves time results in greater production of wealth. But the farmer will never know of these possibilities unless those men of industry who contact him know of the potential savings by the use of electric power.

With a knowledge of agricultural trends and needs, it is apparent that distribution services of the electrical industry have fallen far short of supplying a satisfactory service to farmers. The great potential farm market for electrical equipment and appliances will not be developed until distribution assumes its responsibility of better sales technique, methods and service. Unless this be done sales will be made largely and only in response to demand, by mail order houses, chain stores and cooperatives. None of these institutions ever contribute much to market development or satisfactory service. Markets are never developed by simply supplying a demand; they must be sold.

It is my opinion that too much stress has been placed on electrifying the farm home in relation to emphasizing the great possibilities of lower cost, labor saving, increased production and elimination of waste resulting from applications of electricity to farm jobs. We cannot estimate the importance of electricity in the farm home as a powerful social and economic force to these people. It fulfills a dominating desire to have the home facilities enjoyed by urban dwellers. It saves hours of hard labor in the farm home; it makes life happier and keeps not only young people but farmers themselves on the farm. It marks a great step in social advancement and leads to a more contented life as a result of a higher standard of living. There must be no lessening of effort in electrifying the farm home.

INCREASED FARM PRODUCTION SPEEDS ELECTRIFICATION

We must remember, however, that the land must first produce the income with which to buy home facilities. Production comes first and it is to this that the electrical industry must turn its attention, for through increased production homes will be more quickly electrified. It is not to be implied that none of this work has been done in the past but industry as a whole has not adopted this sales approach. This is probably a result of sales plans having been developed primarily to sell urban customers.

Better Distribution Needed. It is evident therefore that there must be developed more aggressive distribution plans and sales methods based on a concept of productive efficiency through use of electric power. More than two hundred unduplicated uses of electricity are applicable to the farm. One of the reasons why a better knowledge of production increases is not more general to distribution services from manufacturer to dealer is that there has been no central agency for the collection and dissemination of information gained through research and experimental work by agricultural schools, electric utilities, experiment stations, extension services, the Department of Agriculture, manufacturers and other agencies. One national supplier said that 80 per cent of their men did not know what a hammermill is.

There is a wealth of such information but it has never been collected and collated into effective sales data for use by dealers and others who contact the farmer. However, there is sufficient material available to make a powerful and effective sales story for farm market development. We know that electricity in the dairy increases milk and butterfat production from 10 to 25 per cent. The same holds true for poultry and egg production. There is a great field for the study of light as a productive force and in animal husbandry. We have not fully explored the possibilities of motor application to many farm jobs. Convenience is a potent argument for greater uses of the electric *(Continued on page 482)*

2¾% Nickel Steel locomotive rods, one bent cold to show ductility.

QUENCHED AND TEMPERED NICKEL STEEL FORGINGS COMBINE

EXCEPTIONAL DUCTILITY WITH HIGH TENSILE STRENGTH

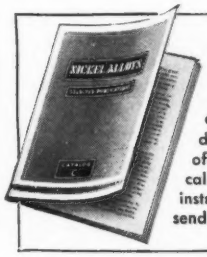
Composition and Typical Properties of Normalized Quenched and Tempered 2¾% Nickel Steel Rods

Description or Size	Melt Yield Pt. No. #s per Sq. In.	Tensile Strength #s per Sq. In.	Elong. % in 2 In.	Reduction in Area %	ANALYSIS					
					Car.	Mang.	Phos.	Sul.	Sil.	Ni
Main Rod....	92900	110000	25.0	64.4	.31	.78	.027	.026	.25	2.75
Main Rod....	86500	104500	25.5	65.6	.32	.86	.034	.032	.29	2.69
Main Rod....	86360	104400	26.0	64.8	.32	.86	.034	.032	.29	2.69
Main Rod....	87850	102350	26.0	66.2	.31	.89	.037	.025	.32	2.69
Front Rod....	86000	102250	25.0	67.3	.29	.82	.035	.027	.24	2.71
Front Rod....	83900	104250	25.0	66.1	.29	.82	.035	.027	.24	2.71
Front Rod....	86850	104250	27.0	66.1	.32	.86	.035	.025	.30	2.65
Front Rod....	89500	107050	25.5	65.6	.32	.86	.035	.025	.30	2.65
Back Rod....	89500	107650	25.0	62.7	.30	.79	.030	.025	.22	2.71
Back Rod....	87500	106450	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	87000	105600	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	88150	104850	26.0	66.8	.29	.82	.035	.027	.24	2.71

Specimens Taken from Mid-Section of Prolongations of the Forgings

The above table compiled by the American Locomotive Company shows the chemical compositions and mechanical properties of some normalized, quenched and tempered nickel steel front, main and back rods recently produced as replacement rods for locomotives being speeded up and rebalanced. These values are typical of replacement rod forgings recently tested by that company.

Quenched and tempered nickel steel forgings provide high tensile strength and ductility, combined with unusual toughness and high fatigue strength—qualities which tend to obviate breakage and assure long, trouble-free service when employed in heavy duty machinery and equipment.



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motor and many other devices. There are many jobs which can be done but are not done because too many "gadgets" are required and too much time consumed in preparing for a labor-saving job requiring but a short period of operation. This subject requires some study and investigation to carry through farm electrification. A notable illustration of labor saving and productive efficiency by electricity is contained in data obtained by an REA survey of forty-one selected Ohio and Indiana farms in 1942. These data show production before and after electrification as follows:

	Number		Per cent increase
	Before	After	
Acres in farms	7,586	9,630	27
Acres (seed corn)	105	290	176
Milk cows	356	520	46
Laying hens	12,530	19,447	55
Chicks (brooded)	50,025	78,750	57
Chicks (hatched)	350,000	807,000	130
Turkeys	11,000	23,000	109
Apples, bu (estimate)	2,000	12,000	500

It will be noticed that 2,044 more acres were cultivated. If the income averaged $25 per acre it would amount to approximately $1250 per farm. This increase was shown by the employment of 103 full-time men against 110 before electrification. Additional income of $1250 would buy many home appliances as well as productive equipment.

A Cooperative Suggestion. There is also today a great need for cooperation between electrical manufacturers and manufacturers of farm implements which can be powered by electricity. The result would certainly produce better design, greater efficiency and probably lower costs for smaller farms. It seems to me that our research and experimental work might be classified under broad headings, namely, (1) cost of operation, (2) time savings translated into labor and dollar savings, (3) increased production at lower costs, and (4) elimination of waste.

A modern electric pressure water system is probably one of the best examples of the first three. A thousand gallons of water can be pumped at an average cost of about four cents. Comparisons of cost with hand pumping are so low as to seem almost incredible. It is common knowledge that milk and butterfat are greatly increased by having at all times and in sufficient quantities an adequate supply of good, clear, healthy water.

One of the best examples of elimination of waste is the simple pig brooder. Approximately ten million litters of pigs are born annually. An average of three pigs is lost at farrowing time. Experiment proves that at least one-half of these may be salvaged by the employment of a 150-w lamp and reflector. If but one-fourth were saved by availability of electricity, over 1½ billion more pounds of pork would go to market each year. However, there is a further great waste elimination. Every pig requires from breeding to farrowing time an average of 120 lb of feed for its production. Saving the above number of pigs — 7½ million — would eliminate a waste of 900 million pounds of feed.

Countless examples might be given but these are sufficient to emphasize the correct approach and the studies which manufacturing and distribution forces must undertake if the farm market for electrical appliances and equipment is to be soundly developed through better and more effective sales methods. No attempt will be made here to give details of how effective distribution may be brought about. Two booklets dealing with this subject have been recently produced by me after three years of study of the subject — "Distribution — The Bottleneck of Farm Electrification" and "Farm Electrification Through Better Dealers." Copies are available on request.

There is another reason, most important to the future of this nation, for keeping approximately one-half our population on farms and in rural towns and villages. This is about the only group of individual and independent thinkers we have left in the United States. If the principles of liberty in which this nation was conceived, if freedom of enterprise is to live, then it is imperative that this group of free thinkers shall be sufficient to balance the scales against organized pressure groups and political machines of large cities, which can be regimented and pave the way for socialization of industry and destruction of freedom of individual enterprise.

One of the principal reasons why rural people take a greater interest in government is the fact that a much higher percentage of them own property than urban dwellers. The latter has become accustomed to "vertical living" in apartment houses. The urbanite owns but little property, pays little real estate taxes and has no great interest in civic affairs. The property owner is decidedly interested in his local government, and this habit creates an interest in state and national government. Where but 23 per cent of metropolitan dwellers know the name of their congressman, 67 per cent of farmers do know his name.

Electricity will play a great part in securing all the desirable ends of agricultural and rural life. The job to be done in farm electrification challenges the best that is in every factor concerned with its accomplishment. It calls for our best research, engineering and sales facilities. In meeting the challenge we will not only develop a great market for electrical equipment and appliances but we will contribute to the prosperity of farmers, the nation, and the preservation of a security of free men who will build an even greater America.

"A Firesafe, Labor-Saving Livestock Compound"

TO THE EDITOR:

I NOTE that discussion is invited of the above-titled article by E. L. Hansen in AGRICULTURAL ENGINEERING for November, 1944.

This is quite an unusual article. The very tone of it makes one wonder if the author has actually had farm experience in handling livestock since there is so much emphasis on mechanical operation. It is presumed that a setup of this kind would be on a farm, but there seems to be a disregard for the use of the land. There may be a saving of labor once one gets the livestock into the barn, but what about the extravagant use of labor in doing this daily, especially when the livestock should run outside.

The article reminds me of a radio talk I heard given by an engineer several years ago in regard to putting up silage on the farm. It was brought out at great length that considerable power could be saved in filling the silo by operating with a small unit which in the end required two or three weeks to fill the silo. Yes, mechanical power was saved, but there was a total disregard for the change and loss in nutrients in the silage by virtue of the change in the maturing qualities of the corn and silage. Yes, mechanical power was saved in the filling process, but the loss in nutrients and other disadvantages greatly overshadowed this saving.

C. E. WYLIE

Head, department of dairying
University of Tennessee

TO THE EDITOR:

I HAVE just read E. L. Hansen's article describing a firesafe, labor-saving livestock compound in AGRICULTURAL ENGINEERING for November, and having noted the appended solicitation of comment, I should like to contribute my bit.

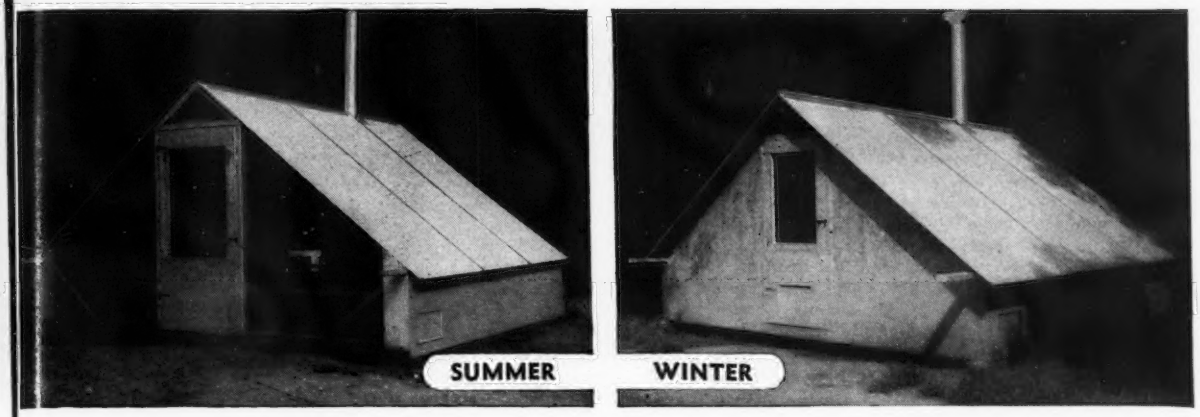
I like the idea. It looks to me like the beginnings of a much needed revolution in farm building design. My first reaction after that, however, is to dislike the idea of no windows. Now I approve heartily of the engineered air conditioning, which of course requires that windows be kept shut for the most part. I also agree that the usual barn window is useless for light transmission, but what about using some glass blocks in this nifty unit? So far glass blocks are expensive, but so is needless daytime artificial lighting on a farm. And it is not inconceivable that the glass blocks may reduce in price as they come into more and more general use. If used properly, it seems to me that a glass block wall would be readily cleaned by means of water under pressure. It would also have the low *U* value desired.

Obviously there are any number of variations on the same theme as that of the article. One which suggests itself at the moment is a two-level plan, similar to that found in many present-day barns on farmsteads whose cow yards lie at a lower level than the farm yard proper. Apparently a further reduction in outside wall area is possible by the use of two floors instead of only one. The upper level would then be used for poultry housing, hay and feed storage, etc., communicating by chutes with the lower level where the other stock might be housed.

The question of financing these "farm plants" is doubtless the biggest factor to be dealt with in selling them. It would be of interest to hear something on that problem too.

A. NELSON DINGLE

Research associate in meteorology
Massachusetts Institute of Technology



Versatility

The adaptability of plywood construction for multi-purpose farm buildings is well illustrated in this small combination poultry brooder house and range shelter.

For years, poultrymen have been seeking an acceptable brooder house design that would be extremely light in weight without sacrificing structural rigidity and other important requirements for such buildings. In this new dual-purpose design Kansas State College has perfected a strong, well-designed house that probably weighs less per square foot of floor space than any similar type of structure. The light-weight, rigid plywood construction facilitates moving without undue racking, adding years of useful life. The tight construction inhibits air infiltration, permitting controlled ventilation. Smooth wall and ceiling surfaces and the wire mesh floor promote sanitation.

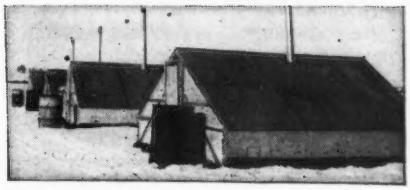
Kansas State College Circular 155 states "The brooder house and range shelter illustrated in this circular combines into one unit of equipment the recommended features of using a portable brooder house and a range shelter for brooding and rearing chicks. This combination house is suitable for brooding chicks or poults, and offers an economical means of furnishing adequate equipment. It is designed to serve as a brooder house during the early brooding period, and then is converted into a range shelter by removing the front and rear panels. This house, due to its light framing and the use of exterior grade waterproof plywood for the roof and sides, is relatively light in weight, considering the size of the building; therefore, it is easy to move to a new location.

"The successful brooding and rearing of chicks to develop good pullets for flock replacement is perhaps the most important factor in operating a profitable poultry enterprise on the farm.

"The sides and roof are covered with one-fourth inch exterior grade waterproof plywood, and the front and rear panels are bolted to the framework and may be removed. When these panels are removed, they should be placed inside the house and attached to the rafters. In this way, they may be protected and available when they are again put in place.

"Some of the outstanding features of this building are:

1. It is economical and simple to construct.
2. It is easy to move at any time, and thereby provides better range conditions.
3. It conserves brooder fuel, due to the low ceiling.
4. It provides a method of regulation openings in the house to adjust to weather conditions.
5. It provides adequate ventilation without drafts.



Exterior type plywood (made with waterproof resin binder) should be used for all permanent outdoor use such as this.

"Two of these brooder houses would be needed on a farm maintaining a farm flock of 300 adult birds.

"The house can be easily moved by using rollers under the runners or by designing a definite sled for this purpose.

"This combination brooder and range shelter has been in use on the Kansas State College poultry farm under practical brooding conditions and has proved to be a most satisfactory brooding unit."

BRIEF SPECIFICATIONS

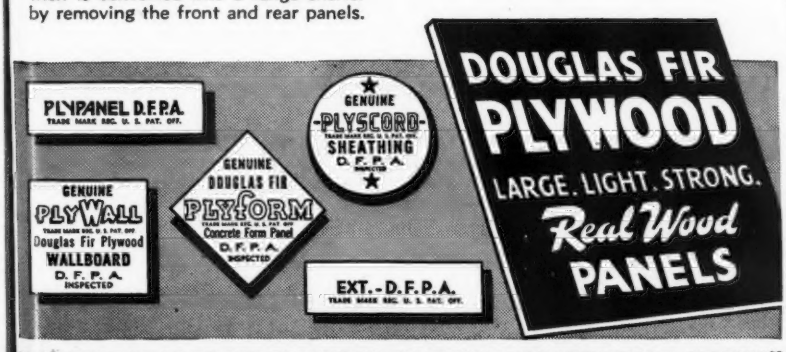
Size: 12 x 12 feet. **Capacity:** 300 chicks.

Floor: Wire on 2" x 4" joists. Six foot square of burlap or muslin placed over wire around brooder for the first four weeks.

Walls: Side walls 21" high above floor. Framing 2" x 3" spaced 4 feet o.c. Covering ¼" Exterior Douglas fir plywood. End wall panels removable.

Roof: Rafters 2" x 2", 24" o. c. Roofing ¼"—4' x 8' Exterior Douglas fir plywood panels extending from ridge to plate.

Painting: Two coats of exterior lead and oil or aluminum paint.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Farm Buildings Are War Equipment . . . Keep Them Fit and Fighting!

DOUGLAS FIR PLYWOOD ASSOCIATION
Tacoma 2, Washington

Farm Equipment in Soil Conservation

By T. B. Chambers
MEMBER A.S.A.E.

ACTION for soil conservation became necessary because of the rapid depletion of the good farm lands in this country. This action must succeed because it is essential that our soils be kept in the best state of productivity if our standards of living are to be maintained. We believe it will succeed because the damages of erosion have been recognized in time and corrective measures have been developed which will control erosion and assure the conservation of both soil and water resources.

Experience shows that conservation work of the type encouraged by the U. S. Soil Conservation Service (SCS) results in immediate increase in yields per acre, along with a decrease in the cost of production, in a preponderant majority of cases. It is to be anticipated that future experiences will show further increases and that sustained yields with conservation will be above those that could have been expected without conservation. There is ample published data to substantiate these statements.

A program that contributes to the well being of the farmer is of vital interest to the farm machinery industry, and therefore it is believed you have a special stake in the progress of soil conservation in this country that is perhaps not equaled by any other industrial group. It is not necessary to remind you that prosperous farmers are good customers. You also known that low income farmers are poor customers. Whether the low income is due to farming lands depleted by erosion, overcropping, or the loss of needed moisture is important because such conditions can be corrected in whole or in part. Low yields due to poor drainage or the inefficient use and improper application of irrigation water can also be improved.

Prosperous farming is not due entirely to high prices, but also to efficient farming methods. Conservation farming provides greater efficiency in the use of land, labor, fertilizer, and seed. It is readily apparent to SCS people that a farmer well equipped with the necessary power and implements is able to do superior work in the installation of conservation practices. The efficiency of his farming operations also is increased by proper adaptation and use of equipment. It seems to me that here the farm machinery industry on the one hand and the SCS on the other have a common interest.

The question as to what the farm equipment industry can do to tie in with the soil conservation program most effectively can be partially answered by a brief review of the program and how it is being carried out.

The program of the SCS is carried on in cooperation with soil conservation districts. These districts are political subdivisions of the state, organized through democratic processes and administered by local bodies composed of farmers or landowners residing in the district. They are authorized to secure assistance from state, local, and federal agencies and from other sources, and to enter into agreements with individual farmers for protection of farm lands in accord with the district program and objectives. When requested, the SCS provides technical and other assistance for planning and installing conservation practices on individual farms or groups of farms. Congress regularly makes funds available to the Service for this purpose. The district governing bodies prepare programs and work plans, determine how assistance from the SCS and other agencies will be used and are responsible to the citizens of the district for the conduct of their work. Except in a very few instances, they have no power to levy taxes or to make assessments. To help meet the need for funds, some of the state legislatures have made appropriations for district use. The first district was formed in North Carolina in 1937 and the last state enabling act became effective in Missouri in July 1943, leaving only three states — Massachusetts, Connecticut, and New Hampshire — without enabling acts. On September 15 of this year 1,154 districts had been organized including more than 640,000,000 acres of land and almost 3,000,000 farms, or about half of the farms in the United States.

A paper presented before the power machinery department of the Farm Equipment Institute during the Institute's annual convention in Chicago, October, 1944.

T. B. CHAMBERS is chief, engineering division, Soil Conservation Service, U. S. Department of Agriculture.

The program is based on sound land use — that is, the use of each acre of land in accord with its individual capabilities, and the conservation treatment of each acre in accord with its individual needs. Capabilities are determined locally and take into account such factors as inherent soil qualities, extent of erosion damage, degree of slope, and climatic conditions. Lands properly used will provide economic returns to the farmer, including the cost of effective protection against erosion damage. Conversely lands used improperly will not yield economical returns after deducting the cost of protection. Most farms contain some land usually a small amount but occasionally a major part of the farm that through improper use is lowering the farm efficiency. Farmers who have adjusted the use of their land in accord with its capabilities report an immediate improvement in the efficiency of their farming operations.

This program also provides for water control practices, such as terraces and diversions with protected outlets, water-spreading works for dry lands, contour cultivation, dams for gully control, drainage and irrigation improvements, farm ponds, and many others.

Then there are the vegetative practices, including crop rotations, winter cover crops, green manure crops, crop residue management, strip cropping, pasture improvement, retirement of eroded or steep lands from cropping, border plantings for wildlife, reforestation and woodland management. Combinations of these practices are adaptable to all parts of the country and those applicable are recommended for the individual farm in accord with the capabilities of the land and the farm management plan.

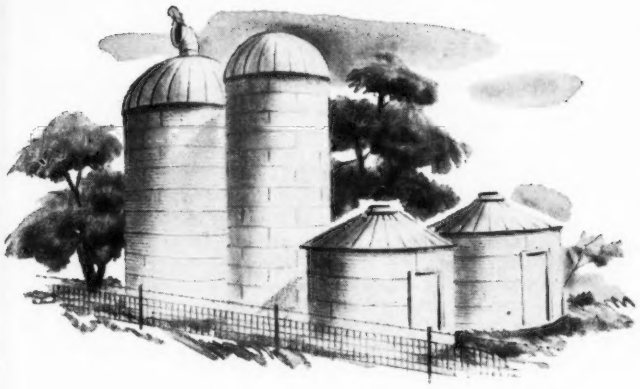
Many of these practices are new to farmers in some parts of the country, but they are being adopted by these farmers as their need and uses are demonstrated. A new crop or practice often creates new equipment problems. These problems can best be solved with the assistance of farm equipment manufacturers.

For a more detailed view of the farmer's equipment problems in a conservation program, we might follow through on the planning for conservation on a farm in one of the southern states. This location is selected because there is need for a greater variety of equipment than has generally been used in that area.

The farm selected has 60 acres of rolling to hilly crop land, mostly farmed to cotton and corn, sometimes alternated between fields. Two or three acres are usually planted to sweet potatoes, sorghum, and possibly some other row crop. There are three acres of low-grade hill pasture and the remainder of the farm is in cut-over woods. The livestock consists of four work mules, one cow, and some hogs. The equipment consists of moldboard plows, a cotton and corn planter, a walking cultivator, fertilizing equipment, and the necessary one-horse cultivating plows for cotton.

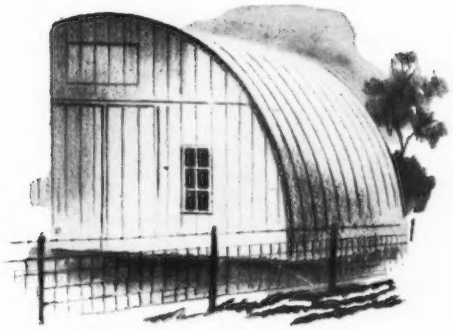
Under the conservation plan, 8 acres of steep eroded crop land on this hypothetical farm may be retired to perennial legumes (kudzu and serecia lespedeza). On about 50 acres, a rotation of cotton, corn, small grain, and lespedeza is established, with a winter cover crop following the cotton. The hill pasture is planted to perennial legumes and a new bottomland pasture is cleared of brush, limed, fertilized, and seeded. All of the crop land is terraced and protected outlets are installed. A woodland management program is established providing for fuel wood and saw timber with protection from grazing and burning.

As the plan is put into use, this farmer will have need for equipment of a kind that he has never owned and may not know how to use. The needs will include a mowing machine for pasture clipping and cutting hay, other hay equipment, a grain drill, soil-packer and disk for seeding, a combine for harvesting small grain and legume seed, and a tractor with attached plows, planters, and tillage implements. He will now have feed for additional livestock and may develop a need for a silage cutter, feed grinder, and manure spreader. To this man the construction of terraces is a problem to be solved by doing the work himself with mule power and slip scrapes; securing a tractor for use with a disk plow, moldboard plow, or small blade; or paying a contractor to do the work for him. It would be economical to use *(Continued on page 486)*



Steel is especially good for round structures like grain bins, silos and hay keepers. It performs well under tension. Also protects from fire, lightning, severe weather, rodents and thieves. Steel buildings cost less for upkeep, last longer.

Steel buildings give better service



A round-roof hay barn offers more storage space in relation to side wall and roof area. Such barns are more easily built of steel. Steel retains its strength, lasts years longer. This steel building, designed for greater efficiency, will boost output, increase profits.

ONE thing the war has proved is the practicality of steel as a building material. Steel can be easily fashioned to any shape and size . . . for conventional or prefabricated buildings . . . and it will stand up under rugged service conditions. The adaptability and toughness of steel make it ideal for farm service.

Steel is strong. It lasts long under the most adverse weather conditions. It protects livestock, stored crops and valuable machinery from rain, wind, fire and lightning. Reasonable first cost plus low upkeep cost over its long service life puts the protection of steel within easy reach of every farmer. And reduced fire hazard is an additional premium for the farmer who builds with U·S·S Steel Roofing and Siding Sheets.

Steel is versatile, too. For tools, machinery and equipment, for low-cost drainage and for rural electrical equipment, steel is unexcelled in strength and durability. No other material can do so many jobs so well.

The metallurgists and engineers who have won recognized leadership for U·S·S Steel and Steel Products are now perfecting products to bring low-cost steel structures and more efficient machinery and equipment to the farmer.

If you are an agricultural engineer or a manufacturer of farm structures, machinery or equipment, we invite you to consult with our staff of experienced technicians.

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CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
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United States Steel Export Company, New York

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UNITED STATES STEEL

a bulldozer for clearing the new pasture site, if such equipment was available. Under his old system this farmer was not a potential equipment customer. Under a conservation program we often find him and many of his neighbors buying equipment of the type mentioned. This farm is one of the 114,000 for which the Service has made conservation plans in the southeastern states.

For any other part of the country the picture for an individual farm would have many similar aspects, in that land-use adjustments would ordinarily be required and new crops and practices would be introduced. The midwestern farmer, who is relatively well stocked with equipment, might still find equipment problems caused by the introduction of terraces, contour cultivation, or other practices, and in some cases by new crops. Drawbar type equipment adapted to flat fields and straight rows may not be as well suited to steep transverse slopes and the curved rows of contour cultivation. The tractor attached types of machines seem to be better suited for contour cultivation on the steeper slopes and along terrace ridges.

In addition to these general problems, there are specific equipment problems in connection with conservation. For instance, war demands for peanuts and soybeans present a problem of erosion control on the bare lands left by the late harvest of these crops. A winter cover crop is often the only solution, but this requires seeding equipment and heavy plows for turning the cover crop in preparation for spring planting. Contour cultivation of potatoes has created an unsolved problem of side slippage of planting and harvesting equipment and difficulties in spraying with multiple-row machines. Contour cultivation of potatoes will be retarded until some of these problems are solved.

Let us look at the picture through the eyes of a representative of the industry. Recently, a representative of the John Deere Plow Company made a study of conservation work in two counties in Virginia. His report to the company included the following statements:

"In both counties we saw farms where the plan had been in operation long enough to transform barren eroded desolate and oftimes abandoned farms into prosperous productive and well-cropped institutions with happy and self-respecting owners. Fields that a few years ago would produce five to ten bushels of corn are now producing sixty bushels or more per acre. Pastures that were barren or smothered with broom sage are now lush with lespedeza, alfalfa or clover. So the program *works*. It is available to American farmers if they will only apply and cooperate.

"If we consider this program from a selfish standpoint we can easily see the increased potential demand for farm equipment. In the program the farmer is taught to make use of the machinery at his command. He does not have to invest in new heavy and expensive equipment. Naturally the tractor is almost a necessity. Mowing machines are used most extensively, since legumes and grasses play an important role. Hence more hay tools are needed. Lime and fertilizer sowers of all types are used. But most important of all is the fact that the purchasing power of the farmers is increased. They can buy more and better equipment."

FARM EQUIPMENT COMPANIES CONTRIBUTE TO CONSERVATION

Some of the farm equipment companies have already contributed materially to the progress of sound conservation through the preparation of educational material, such as bulletins, pamphlets, advertisements, motion pictures, etc.

It is my understanding that some companies have also conducted training activities within their own organizations for the benefit of sales and technical personnel. Representatives of several companies have studied soil conservation equipment problems in the field with SCS people and farmers. I personally recall that representatives of Allis-Chalmers, J. I. Case, John Deere, and International Harvester have made field trips with our people for this purpose, and there may have been others of which I am not informed. As a result of these studies the International Harvester Company is currently engaged in conducting a series of demonstrations for SCS personnel that is valuable to our people in learning the limitations in use of equipment for conservation farming.

Such information will enable our people to adjust conservation practices to the farmer's equipment within reasonable limits. For instance, a three-row lister or planter may not successfully perform on a terrace of standard cross section but could be used if the terrace ridge was made a few feet wider. We have the same responsibility for adjusting practices to equipment that you have for adjusting equipment to practices.

In conclusion, may I make the following suggestions about the things the farm equipment industry can do in the interest of soil conservation:

1 Continue the preparation of informational material on conservation practices and methods. Illustrated bulletins, leaflets, and motion pictures are all desirable, necessary, and in great demand.

2 A type of information that would have considerable value is a description of the best use of specific kinds of equipment in conservation farming. For instance, photographs or motion pictures of combines working on terraced fields; laying out contoured rows on terraced fields with two-row or three-row equipment; spraying and digging contoured potatoes; plowing for terrace maintenance; cutting kudzu with a mower; crossing grassed waterways with disk harrows, plows, and other tillage implements so as not to destroy the vegetation used for lining, and many other features. I see no reason why such information should not be used to advertise your individual products. I am sure it would be immensely valuable to many farmers just beginning their conservation work. Such information might be prepared in leaflet form for the use of customers, or in motion picture form for the use of prospective customers.

3 Individual companies should review regional equipment needs and market opportunities in the light of conservation farming problems. Such studies should aid the companies in adjusting or distributing their products in accord with the needs in a particular farming region. This suggestion is prompted by the fact that dealers do not always have available types of machines needed, although they may be produced for some other section.

4 For equipment manufacturing companies to make their greatest contribution to the conservation program, it is essential that each level of organization have a sincere desire to cooperate. District representatives, distributors, branches, blockmen, and dealers must all be informed so they can carry out the policies the companies have established. Many dealers have great influence with local farmers and can encourage or delay a program in their territory.

SOIL CONSERVATION SERVICE COOPERATES WITH INDUSTRY

The SCS stands ready to cooperate with the industry in carrying out these suggestions to the limit of our available resources, and company representatives should feel free to call on our regional or Washington offices at any time for advice and assistance. A close working relationship between dealers and district governing bodies would no doubt prove mutually beneficial.

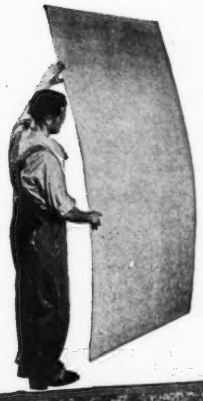
The Soil Conservation Service has compiled the following data on the extent of soil conservation work needed in this country which serves as an indication of the job to be done:

- 130 million acres of contoured cultivation
- 95 to 100 million acres of terracing
- 670,000 dams for stock water
- 2,300,000 acres of water spreading or flood irrigation for improved pasture and range forage and erosion control
- 35 million acres of winter cover crops for southern states
- 101 million acres of strip cropping
- 83 million acres of rotation or pasture (37 million acres in the corn belt)
- 96 million acres of liming pastures (48 million acres in the corn belt)
- 129 million acres of mowing pastures (51 million acres in the corn belt and 25 million acres in the Southeast)
- 131 million acres of seeding range and pasture
- 11 million acres of perennial hay crop, of which 5½ million acres are in the southeastern states and would consist primarily of kudzu and serecia lespedeza
- 7 million acres of crop residue management are needed in northern Great Plains area

The following publications contain information on the benefits of conservation farming: Farmers' Bulletin 1909, "More Food through Conservation Farming"; and Farmers' Bulletin 1942, "Good Pastures".

A Correction

ATTENTION is called to a transposition of captions of Figs. 3 and 4 at the top of page 422 in AGRICULTURAL ENGINEERING for November, in the article, entitled "Barn Curing of Hay with Heated Air," by John Strait.



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NEWS SECTION

Pacific Coast Section Meeting

IT has been announced by Oscar W. Sjogren, chairman of the Pacific Coast Section of the American Society of Agricultural Engineers, that the next annual meeting of the Section will be held at Davis, Calif., January 17. Members of the Society, whether or not they reside in the territory of the Section, as well as non-members interested in the subjects to be featured on the program, will be cordially welcome at the meeting.

The meeting will be held in the agricultural engineering building on the University of California campus at Davis. The program for the forenoon session features three papers by members of the University faculty: Mechanical features of farm dehydrators, by B. D. Moses of the agricultural engineering division; maintenance of egg quality by cooling on the farm, by F. W. Lorenz of the poultry division, and housing of farm labor, by R. F. Maxwell of the agricultural extension service. A luncheon will follow the forenoon session, at which there will be a speaker still to be selected. The Section business meeting will follow the luncheon.

The opening topic for the afternoon session is farm labor saving devices. J. P. Fairbank, extension agricultural engineer, University of California, will talk on the pickup sack loader, and F. E. Price and R. N. Lunde of the agricultural engineering staff of Oregon State College will talk on the mechanical filbert nut picker. Stubble mulch cultivation will be the subject of a paper by L. N. Brown, extension specialist in soil conservation of the University of California, and L. D. Doneen of the irrigation division of the University will present a paper on factors affecting irrigation practice.

Driftmier an Officer of R.F.B.I. Council

INFORMATION not available at the time the item on the Rutgers Farm Buildings Institute was inserted in the last month's issue of this journal reveals that at the first meeting of the National Advisory Council of the Institute early in October, R. H. Driftmier, was elected vice-chairman of the Council. Mr. Driftmier is head of the agricultural engineering department, University of Georgia, and is currently president of the American Society of Agricultural Engineers.

Dr. W. H. Martin, dean of agriculture, Rutgers University, is chairman of the Council which is composed of twenty-six experts in dairy husbandry, poultry husbandry, animal husbandry, and agricultural engineering representing sixteen states and the District of Columbia. As stated in these columns last month, the agricultural engineers having membership on the Council include, in addition to Mr. Driftmier, D. G. Carter, W. C. Krueger, Wallace Ashby, A. M. Goodman, Dr. R. W. Trullinger, and C. E. Seitz. Mr. Carter is chairman and Mr. Krueger secretary of the agricultural engineering group on the Council, and Lindley G. Cook is secretary of the Council.

The Rutgers Farm Building Institute was made possible by a grant from the John B. Pierce Foundation of New York.

Washington Section Meeting

The December meeting of the Washington (D.C.) Section of the American Society of Agricultural Engineers featured an inspiring address, entitled "Agriculture's Future Frontiers," by Wheeler McMillen, editor-in-chief of "Farm Journal and Farmer's Wife" and president of the National Farm Chemurgic Council. The meeting was held on December 6 at Washington in the USDA auditorium.

The next meeting of the Section, which will be a luncheon meeting, will be held on January 4. The program for the meeting will be announced shortly. Non-residents of Washington and vicinity may obtain information regarding the program from D. B. Krimgold, Section secretary, Soil Conservation Service, USDA, Washington.

"A.S.A.E. Week" Group Conferences

AS previously announced, in lieu of the usual fall meeting of the American Society of Agricultural Engineers held in the early part of December, a series of committee and other group conferences are being held this month during the five-day period of December 11 to 15 at the Stevens Hotel, in Chicago.

In addition to meetings of the Council, the Cabinet, Jury of Awards, and Meetings Committee, other committees of the Society have scheduled the following conferences: Committee on Hay Harvesting and Storage, Committee on Farm Structures Advancement, Committee on Curriculums, Committee on Cooperation with S.P.E.E. and A.L.G.C.U., Committee on Farm Safety, Committee on Farm Electric Equipment, Committee on Extension, and Committee on Training Foreign Students. In addition a group of the Soil and Water Division has arranged for a conference on drainage and irrigation problems.

A.S.A.E. Meetings Calendar

December 6, 7 and 8 — Barn Hay Curing Conference (sponsored by Southeast Section), Andrew Johnson Hotel, Knoxville, Tenn.

February 19 and 20 — Southeast Section, Piedmont Hotel, Atlanta, Ga.

January 17 — PACIFIC COAST SECTION, agricultural engineering building, University of California, Davis.

J. B. Davidson Honored

AT A delightful ceremony held in the Memorial Union building on the Iowa State College campus on November 18, Dr. J. B. Davidson, a charter member and first president of the American Society of Agricultural Engineers, was specially honored for his long and invaluable service to agriculture in general and to agricultural engineering in particular. The occasion was the presentation of a portrait of Dr. Davidson, a gift of agricultural alumni, to Iowa State College, to which Dr. Davidson went in 1905 to become professor of agricultural engineering and where for most of the intervening years he has served as head of the agricultural engineering department.

Presiding at the presentation ceremony was R. H. Driftmier, president of the A.S.A.E. Speakers for the occasion included Leonard J. Fletcher, a past-president of A.S.A.E., who spoke on Dr. Davidson as the agricultural engineer. He was followed by Dr. R. M. Hughes, president emeritus of Iowa State College, who spoke of Dr. Davidson as the teacher. Arthur W. Turner, also a past-president of A.S.A.E., discussed Dr. Davidson as the man, and at the conclusion of his talk, Mr. Turner as chairman of the special alumni committee presented the portrait of Dr. Davidson to Iowa State College. It was accepted on behalf of the College by President Charles E. Friley.

A reception for alumni and friends was held following the presentation ceremony.

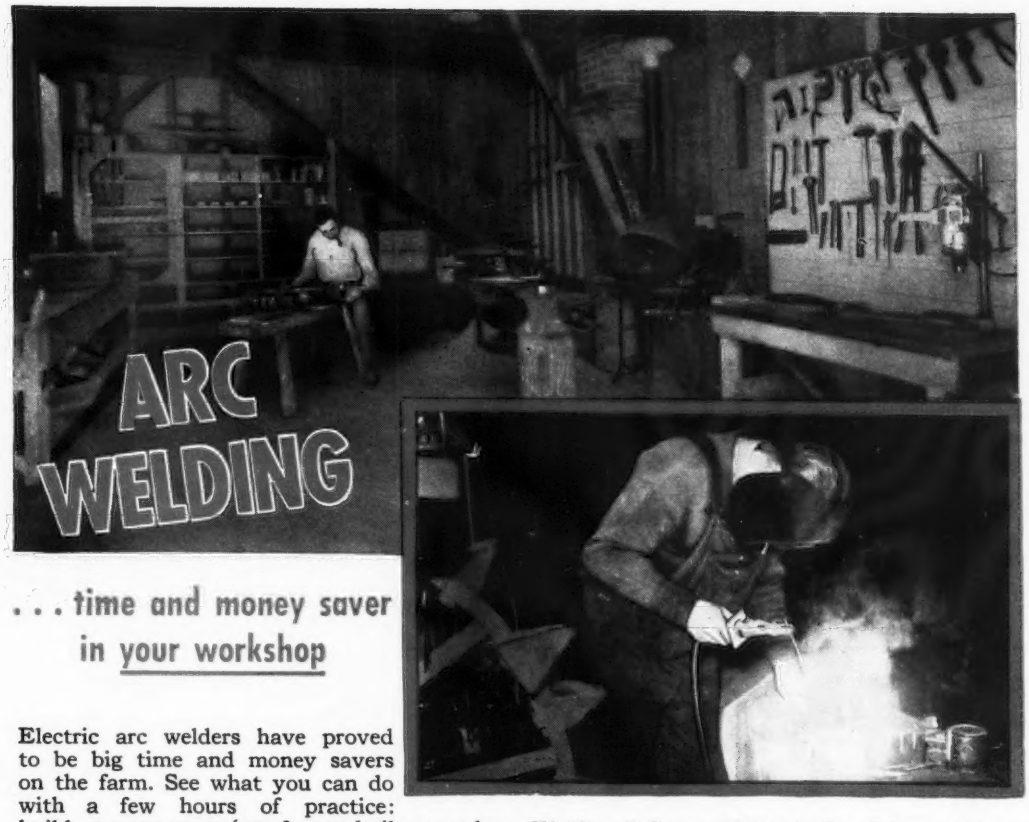
Pennsylvania Section Organized

AT A meeting held November 16 in the agricultural engineering building at Pennsylvania State College, the Pennsylvania Section of the American Society of Agricultural Engineers was organized. Twenty-four A.S.A.E. members and several guests were in attendance.

The meeting was opened with a talk by R. U. Blasingame, head of the agricultural engineering department of Pennsylvania State College, in which he cited the following reasons for recommending the organization of the Pennsylvania Section: (1) Advancement of the theories and practices of agricultural engineering together with development and maintenance of the highest professional standing among A.S.A.E. members in Pennsylvania; (2) cooperation in civic affairs and in promotion of education and stimulation of agricultural engineering activities; (3) providing opportunities for agricultural engineers and students to become acquainted, to keep technically up to date, to cooperate with engineers in other fields, and to promote group activities and (4) providing opportunity for members in all technical groups of the Society to come together for a better understanding of their respective problems.

The forenoon session was devoted mainly to a panel discussion of soil and water conservation, in which H. J. Raths and R. S. Calkins of the U. S. Soil Conservation Service discussed, respectively, the need for soil conservation work and the general program of the S.C.S. and the need for training engineering personnel in soil conservation programs. The third speaker was E. W. Schroeder of Penn State College who talked on cooperation of the college in connection with such programs and also spoke briefly on mole drainage.

At the luncheon, Ladd Haystead, author and agricultural consultant of Fortune Magazine, was the *(Continued on page 490)*



. . . time and money saver in your workshop

Electric arc welders have proved to be big time and money savers on the farm. See what you can do with a few hours of practice: build up worn parts (one farmer built new edge on hay bailer shaft in two minutes—got in his hay before a storm broke—figured he saved $100 on this job); repair broken parts; even build equipment—elevators, hoists, auto tractors, racks, carriers, etc. You might also make money with it by doing repair jobs for your neighbors.

Here's a typical set for farm use:

1. 100-amp welder for use on a 230-volt line—costs $98.
2. Accessory package containing hand shield, cable, electrode holder, and assorted electrodes—costs $15.

The G-E welding distributor nearby will help you select the welder (new or used) best suited to your needs. He will gladly tell you how to use the equipment, and what electrodes are most useful for farm work. Send for Bulletin GEA-3329, "How to Repair Tractor Parts by Welding." *General Electric Co., Schenectady 5, New York.*

GENERAL ELECTRIC

It's patriotic and profitable to send your wood to war. Ask your county agent about selective cutting and nearby markets.

IS YOUR WORKSHOP READY FOR WINTER WORK?

1. Is it arranged to handle any type of job—with room for large machinery?
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4. Is it adequately heated? Could you use an electric heater?
5. Does it have labor-saving tools, such as electric grinder, motor, saw, and welder?

NEWS SECTION

(Continued from page 488)

speaker, and in his talk Mr. Haystead stressed the need for agricultural engineers to become better salesmen of their particular training and experience.

The afternoon program featured a discussion of mow curing of hay, led by J. B. Stere of the West Penn Power Co., D. C. Sprague of Pennsylvania State College, and R. A. Blackburn of the Robinson Ventilating Co. The concluding number on the program was a talk on the experience of the Cooperative G.F.L. Farm Supplies in the repair of electric fence controllers by Gil Cross of that organization.

At the business session held in connection with the meeting, R. A. Knight, division manager of the Pennsylvania Power Co., was elected chairman of the new Section; Paul J. Newton of Hertzler & Zook Co., vice-chairman, and E. W. Schroeder of Pennsylvania State College, secretary-treasurer. A nominating committee consisting of J. S. Webb, A. M. Best, and B. P. Hess was also elected.

Personals of A.S.A.E. Members

Gustav H. Bliesner until recently instructor in physics (ASTP) at Iowa State College, is now employed as extension electrical-agricultural engineer with the agricultural extension service of the State College of Washington. He is also enrolled as a graduate student and is working for a Ph.D. degree.

W. H. Dickerson, Jr., has resigned as assistant agricultural engineer at Virginia Polytechnic Institute to accept appointment as associate agricultural engineer in the agricultural engineering development division of the Tennessee Valley Authority at Knoxville.

Ellis G. Diseker, formerly a member of the agricultural engineering staff at Alabama Polytechnic Institute, after serving in the country's armed forces for three years and two months, twenty months of which were spent in the South Pacific, recently returned to a civil status as a lieutenant colonel in the Reserve Corps, and is to be engaged as an agricultural engineer in research work with the U. S. Soil Conservation Service.

Ben W. Faber has resigned as rural service supervisor for the Portland General Electric Co., to go into business for himself at Hillsboro, Ore. He is establishing a dealership in electric equipment for the home and farm and will handle water systems, irrigation equipment, electric brooders, cream separators and other items for farm electric application.

Robert E. Hartsock recently resigned as inspector in the aircraft division at the Rockford Works of the J. I. Case Company, and is now chief production engineer of the Sawyer Electrical Manufacturing Company at Monterey Park, California.

Julian M. J. Juantorena, engineer, Agronomoy Pecita Quimico Azucarero, of Jovellanos, Cuba, is temporarily in the United States studying problems connected with cane sugar, sugar and by-products, alcoholic fermentation, etc., and is located at the Cuban Consulate in Washington.

Geo. W. Kable, editor "Electricity on the Farm," was honored in October by being unanimously awarded one of the three 1944 Certificates of Recognition at Large by the Grand Council of Epsilon Sigma Phi, the national honorary agricultural extension fraternity, at its meeting in Chicago. The recommendation for this award was made on the basis of Mr. Kable having served as a county agricultural agent and an agricultural engineering extension specialist, for being a past-president of the American Society of Agricultural Engineers, and for, among other things, his outstanding help to agricultural extension work in the practical applications of rural electrification.

George Krieger, who has been in charge of the farm machinery division of the War Production Board and more recently special assistant to Donald N. Nelson, former WPB chairman, has resigned and will return to the Ethyl Corporation, where he will be in charge of rural marketing and special development work.

O. H. Lovelace who has been consulting designing engineer for the Canadian Co-operative Implements, Ltd., at Regina, Saskatchewan, has recently accepted a position as designing engineer of National Farm Machinery Co-operative, Inc., Shelbyville, Ind.

(Continued on page 492)

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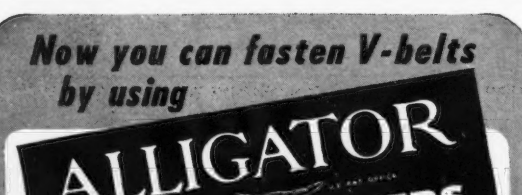

● Alligator V-belt Fasteners and the open-end V-belting now being made by belting manufacturers, will enable you to make up multiple V-belt drives from roll belting. These fasteners have been on the market 9 years and are now being used on a wide variety of drives.

Available for B, C, D sizes of belt for industrial use and 1-in. and 2-in. sizes for railroad use. These fasteners, however, should not be used for repairing endless cord V-belts.

Bulletin V-205 will give you complete details as to where and how these fasteners are used, sizes, list prices, tools and application instructions. A copy will be mailed at your request.

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4677 Lexington Street, Chicago 44, Illinois

Also sole manufacturers of Alligator Steel Belt Lacing for flat transmission belts and Flexco HD Belt Fasteners and Rip Plates for fastening and repairing conveyor belts.

NEWS SECTION

(Continued from page 490)

Joe Mader has resigned as tractor and implement engineer of the S. L. Allen & Co., to become chief engineer of the agricultural division of Maremont Automotive Products, Inc., Cicero, Ill. His new work will include product engineering, designing, and consulting.

George E. Mullin, Jr., who has been serving as manager of the farm sales section of the appliance and merchandise department of General Electric Company, is now sales manager of the company's electric sink and cabinet division.

George B. Nutt, who served for about one year as agricultural engineer with the Office of Foreign Agricultural Relations, U. S. Department of Agriculture, has now returned to Clemson, South Carolina, to take up his duties again as head of the agricultural engineering department of Clemson Agricultural College. He will retain a connection with the OFAR as collaborator.

Howard M. Railsback, director of advertising, Deere and Co., was honored by the 17th national convention of the Future Farmers of America, held at Kansas City early in October, by being awarded the honorary degree of "American Farmer."

S. C. Turkenkoph has been advanced from his position as manager of engineering to that of vice-president in charge of engineering, B. F. Avery & Sons Co., Louisville, Ky.

Richard L. Witz and *Arthur J. Bell*, extension agricultural engineers, Michigan State College, are joint authors of Extension Bulletin 265, entitled "Mechanical Gutter Cleaners," recently issued.

Earl R. Young, associate professor of agricultural engineering, University of Kentucky, is one of the authors of a series of reports on the Farm Work Simplification Project study of tobacco production during 1943-44. The complete series includes leaflet 73 "Pulling Tobacco Plants," leaflet 75 "Machine Setting of Burley Tobacco," and leaflet 86 "Taking Down, Bulking, Stripping, and Pressing Burley Tobacco."

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

O. Harold Arndt, design and layout, J. I. Case Co., Racine, Wis. (Mail) 1309 Walton Ave.

Thomas W. Bohmker, product research engineer, Deere & Co., Moline, Ill.

Walter W. Carson, manager, rural service dept., West Penn Power Co., 14 Wood St., Pittsburgh, Pa.

Alfredo T. Chappuis, agricultural engineer, Asociacion Peruana de Productores de Ozucar, Lima, Peru.

William N. Craig, capt., radar officer, 48th AAA Brigade, USA. (Mail) Box 368, Oxford, Miss.

Talmadge E. Duncan, agricultural engineer, South Carolina Department of Education. (Mail) Calhoun Rd., Clemson, S. C.

M. V. Engelbach, manager, field engineering, The Ruberoid Co., 500-5th Ave., New York, N. Y.

Samuel D. Gray, northeast manager, agricultural research, American Potash Institute, Inc., 1155 16th St., NW, Washington 6, D.C.

Harold L. Newel, capt., USA. (Mail) 80th F. A. Bn., APO 6, c/o P. M., San Francisco, Calif.

Richard M. Putney, director of purchasing, Coop. G. L. F. Farm Supplies, Inc., Ithaca, N. Y. (Mail) Terrace Hill.

W. R. Redman, farms manager, Westminster Canners, Ltd. (Mail) Bradner, B. C., Canada.

Charles B. Seckinger, capt., USA. (Mail) Ord. Dept., G-1 Section, HQ, USAFIME., APO 787, c/o P. M., New York, N. Y

Dean C. Seitz, assistant manager, commercial refrigeration, York Corp., York, Pa. (Mail) 484 Country Club Rd.

Frank L. Walker, division rural service representative, Ohio Power Co. (Mail) 34 S. Monroe St., Tiffin, Ohio.

George E. Webster, instructor in agricultural engineering, University of Vermont, Wateman Bldg., Burlington, Vt.

TRANSFER OF GRADE

Dale O. Hull, lubrication engineer, Standard Oil Co., (Ind.), Chicago, Ill. (Mail) 5959 Kenmore. (Junior Member to Member)

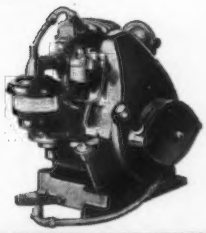
Fox Hole Fog Generator

No larger than a soldier's foot locker, the M-2 bantam smoke generator can make fog from a foxhole. Its mobility brings large-area smoke screens to beachheads, mountain passes and jungle trails for the first time in history.

Smoke-screen protection for front line and amphibious operations, where space is at a premium, is provided for the first time by the new, highly mobile M-2 mechanical smoke generator. Weighing only 180 pounds, this midget can blot out, under favorable wind conditions, an area five miles long and 200 yards wide.

The Lauson single cylinder air-cooled gasoline engine powering the unit is specially designed for military use. Operating efficiency of the engine is safeguarded against extreme conditions of dust and other atmospheric impurities by a United Oil Bath Air Cleaner. Thousands of similar engines are in use by the Air Forces, Chemical Warfare Service and Navy on a variety of applications.

Many new uses in agriculture and industry for small power units like this will result from their ingenious applications to military purposes. And the same standards of performance which have distinguished United products used on war equipment and on farm machinery, tractors, cars and trucks for over 19 years, will be ready for high-production needs tomorrow.



A Lauson RS special one cylinder gasoline engine made of aluminum operates the unit, consisting of boiler, blower and gear pump; it makes smoke in 40 seconds from a cold start.

Dust protection is afforded by the United Oil Bath Air Cleaner Model H30-12480 shown above.

UNITED SPECIALTIES COMPANY

UNITED AIR CLEANER DIVISION
CHICAGO 28, ILLINOIS

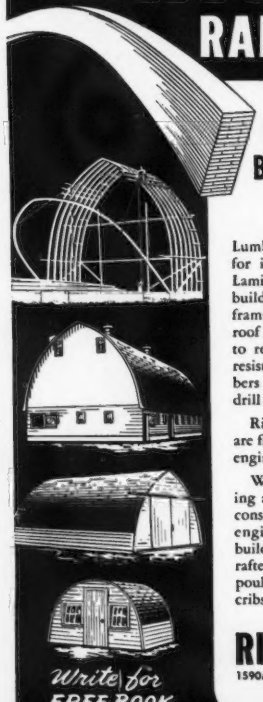
MITCHELL DIVISION
PHILADELPHIA 36, PA.

AIR CLEANERS ★ METAL STAMPINGS ★ HIGH PRESSURE HOSE CLAMPS ★ IGNITION SWITCHES ★ ROLLED SHAPES ★ DOVETAILS

The cylinders on all V-type Wisconsin Air-Cooled Engines are cast in pairs, separate from the crankcase, for quick, economical servicing when required. In case a cylinder is accidentally scored beyond the possibility of reboring, it is only necessary to replace a relatively inexpensive pair of cylinders instead of an entire engine block. The picture shows the Model VE-4 Wisconsin Engine, with protective shrouding removed, illustrating method of attaching cylinders.

Most H.P. per pound WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

RILCO Laminated Wood RAFTER ARCHES



Engineered and Factory-Built for Many Types of Farm Buildings

Lumber dealers can deliver to the farm, ready for immediate erection, many types of Rilco Laminated Wood Rafter Arches for better farm buildings. Rilco Rafter Arches are continuous framing members. They combine sidewall and roof into a single framing unit from foundation to roof ridge assuring a stronger, more wind-resistant building. Rilco laminated wood members are used in Army and Navy airplane hangers, drill halls, factories and storage buildings.

Rilco pre-fabricated poultry and hog houses are factory-built, delivered ready for use. They are engineered for strength, durability and long life.

Write today for the new Rilco book illustrating all types of Rilco rafter arches used in farm construction. The Rilco book provides data on engineering, estimating and erection of Rilco buildings. It shows in detail types of laminated rafter arches available for barns, machine sheds, poultry, hog, utility buildings, granaries and corn cribs. Get full details on building the RILCO Way!

Write for FREE BOOK

RILCO LAMINATED PRODUCTS, INC.
A Weyerhaeuser Institution
1590AE First National Bank Building, Saint Paul 1, Minnesota

PROFESSIONAL DIRECTORY

Consulting Engineering Work In Farm Structures Field
Also Sales Engineering for Selected Manufacturers

GEORGE R. SHIER, A. E.

Member A.S.A.E. Associated with Howard S. Sterner Company, Consulting Structural Engineers, 30 East Broad Street, Columbus, Ohio

Consulting Agricultural Engineer & Farm Market Analyst

FRANK J. ZINK, A. E.

Member A.S.A.E. Suite 4300, Board of Trade Bldg.,
Telephone: Wabash 1558 141 W. Jackson Blvd., Chicago 4, Ill.

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

New Literature

"MECHANICS OF FARM MACHINERY," by A. W. Clyde, professor of agricultural engineering, Pennsylvania State College. Paper, 6x9 inches. Prices: 50 cents per copy; six copies for $2.50 (to schools and to individuals in public service agencies). Order from A. W. Clyde, 204 Woodland Drive, State College, Pa. (Supply limited.)

This is a reprint of a series of six articles by the author published in "Farm Implement News," Chicago, from January 6 to March 16, 1944.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any Notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

RESEARCH ENGINEER wanted for work in farm structures and rural electrification in a land-grant college in a north central state. A young man is preferred. Salary will depend upon qualifications. Write giving full details of education, experience, draft status, and other particulars. PO-174

FACTORY MANAGER with agricultural engineering background wanted to take charge of a small factory producing barn equipment and hay tools. A permanent position for a man with executive ability and one who is interested in research and development. In first letter give full details as to education, experience, family status, age, etc. PO-173

SALES MANAGER wanted. An old-established, expanding company in western New York employing about 150 persons requires the services of a man experienced in the sale of farm machinery. When applying, give full details as to experience, family, salary, etc. PO-172

MECHANICAL ENGINEER and draftsman required by expanding farm machinery plant with postwar future. Please give full details as to education, experience, qualifications, draft and family status and present salary. Include photograph if possible. PO-171

AGRICULTURAL ENGINEER wanted by January for teaching and research work in agricultural engineering in a western state college. Must be able to handle farm power and machinery and farm repairs for both agricultural students and for training Smith-Hughes teachers. A man with teaching experience preferred, but would consider one with good personality and background who has had extension or practical experience in agricultural engineering. Write giving full details. PO-170

(Continued on page 496)

They're Going Overboard For Victory—Are YOU?

USE 8-POINT PLAN FOR AN OVERBOARD DRIVE IN THE 6th WAR LOAN!

NOV. 20th TO DEC. 16th

Our fighting men still have a long way to go! But—your plant-wide selling of the 6th can do much to shorten their embattled miles—lessen the price they so willingly pay for victory! Join the coast to coast parade of patriotic firms that are assuring an **"overboard" showing in the 6th** by following through on **every** point in the 8-Point Plan.

Start the ball rolling by appointing a **6th War Loan Bond Committee,** representing labor, management and other groups.

Carry on by selecting a **Team Captain**—preferably a returned veteran—for every 10 workers.

Right at the start, establish a **Quota** for each department—and every employee.

Arrange frequent **Meetings of Captains,** highlighting importance of their work—effective sales methods—and need for painstaking study of Treasury Booklet, **Getting The Order.**

6th WAR LOAN

Make definite **Assignments** to those best equipped to arrange music, speeches, rallies, competitive progress boards and meeting schedules.

Issue **Individual Pledge Cards**—made out in the name of each worker and providing for both cash and installment purchase.

Resolicit! This is the secret of "overboard" War Bond subscriptions. Your State Payroll Chairman has a special Resolicitation Plan for you to put into action near the end of the campaign.

Give generously of your **Advertising Space** to drive home the War Bond story.

The Treasury Department acknowledges with appreciation the publication of this message by

AGRICULTURAL ENGINEERING

This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council

SAVE SILAGE
by
SEALING LEAKY SILO DOORS
with
SISALKRAFT

SISALKRAFT has been used, as illustrated, to prevent infiltration of air around leaky silo doors — thereby preventing spoilage of the ensilage. The roll is raised as the silo is filled. The silage holds the SISALKRAFT in place.

It has also been found that sealing the tops of permanent silos with SISALKRAFT saves as much as $20 worth of silage.

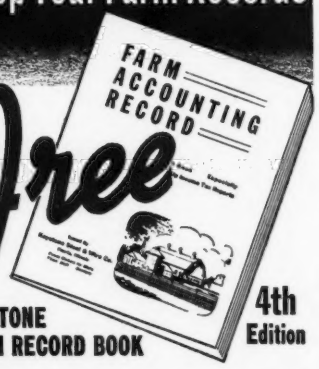
A new folder illustrates and discusses these and many other agricultural uses of SISALKRAFT. Copies are yours on request.

SISALKRAFT is sold through lumber dealers everywhere.

THE SISALKRAFT CO.
205 W. WACKER DRIVE, CHICAGO 6, ILL.
NEW YORK SAN FRANCISCO LONDON SYDNEY

Manufacturers of SISALKRAFT, FIBREEN, SISAL-X, SISALTAPE AND COPPER-ARMORED SISALKRAFT

The EASY Way to Keep Your Farm Records



KEYSTONE FARM RECORD BOOK 4th Edition

Simplifies Income Tax Reporting

The favorite record book of thousands of farm owners and managers for the past 3 years. Easily kept, yet complete. Especially designed for helping prepare your income tax report. Also very useful when dealing with banks and government agencies. Helps improve farm operations, too. Thirty-two pages, complete. *Write for your free copy today.*

KEYSTONE STEEL & WIRE COMPANY
777 Industrial Street Peoria 7, Illinois

RED BRAND FENCE
—and RED TOP STEEL POSTS—

EMPLOYMENT BULLETIN

(Continued from page 494)

AGRICULTURAL ENGINEER (graduate) specializing in farm structures wanted for resident job in Northwest in plywood research on laboratory and agricultural construction projects. Good personality, initiative, ability to organize and complete projects, and ability to write reports and address technical groups required. Give personnel record, photograph, specimens of draftmanship and technical report writing and salary expected with application. Special consideration given ex-service men. PO-169

ENGINEERS, DRAFTSMEN wanted by a well-known manufacturer of farm and garden implements to develop and design new tools, garden tractors and equipment. Positions permanent. Write giving age, salary expected, and full qualifications. PO-168

FARM STRUCTURES MAN wanted by large company for expanding program in prefabricated farm buildings and components. Excellent opportunity for man qualified in functional phase of design and promotion. Replies should indicate scope of training and experience. Confidential. PO-167

SALES ENGINEER wanted for permanent position with small company producing well-accepted building material products. Substantial base salary, better than average proposition for man with liking for sales work and knowledge of building construction. Give full information on past experience and earnings expected. PO-166

AGRICULTURAL PRODUCT ENGINEER wanted for mechanical designing and development of corn pickers, combines, and other harvesting machines. Permanent position with old well-established midwest manufacturer with national distribution. Located in fine city with adequate housing and educational facilities. Big postwar farm market assures future. Salary open. Good opportunity for advancement. Write experience, qualifications, draft status, and other particulars in your letter. PO-165

AGRICULTURAL ENGINEER wanted by a well-known national organization to engage in sales promotion work on farm buildings, preferably someone in his early thirties with good engineering training and farm background and with plenty of initiative and ingenuity. Special training in farm buildings would be helpful to person selected. Discharged service men will receive special consideration. Write giving full details as to education, experience, etc. PO-164

SALES ENGINEERS, preferably 32 to 38 years of age, with college education in engineering and with sales experience, are wanted by a large national manufacturing organization to engage in the sale of farm buildings through dealers. While a postwar project, qualified applicants will be interviewed now. Special consideration will be given discharged service men who have qualifications sought. Write giving full particulars as to education, experience, etc. PO-163.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B.S. degree in agricultural engineering from the A. & M. College of Texas is available for employment. Reared on farm with experience and knowledge of operating, repairing and caring for farm machinery. Experienced in farm shop and wood working tools, farm buildings and animal husbandry. Eight years in public school teaching work. Two years in structural aircraft detail and layout drafting. Age 33. Married, with two children. Would like position in design and experimental work on farm machinery. PW-366

RESEARCH ENGINEER (electrical-agricultural) is available. Has a bachelor of science degree in electrical engineering (1933), master's degree in agriculture (1934), degree of agricultural engineer (1939) and is now working for a Ph. D.; also has engineering license. Temporarily employed as an extension electrical-agricultural engineer on wartime food production problems. Ten and one-half years' experience since earning master's degree in agriculture; four and one-half years' in government civil service, and five and one-half years' in other than government service. Born and reared on a farm. Thirty-four years of age, married, two children. Available at a salary range of from $4000 to $8000 per year. PW-365

AGRICULTURAL ENGINEER with a B. S. degree in agricultural engineering from an eastern college is available for employment. Experience in soil conservation, drainage, and use of explosives in land drainage and land clearing; farm reared with experience and knowledge of the operation, care, and adjustment of farm machinery and equipment, also wood-working equipment and farm building construction. Age 38, married, two children. Would like position in teaching, research, or extension work. PW-362

DEC 18 1944

AGRICULTURAL ENGINEERING

DECEMBER 1944

Fire Fighting Methods and Equipment for Rural Communities *H. G. Ingerson*

New Developments in Timber Construction for Farm Buildings *L. P. Keith*

Factors in the Design of Bulk Storage Bins for Rice *H. A. Kramer*

The Development of Agricultural Land for Irrigation Purposes *W. O. Wallinder*

Agricultural Engineering . . . Accrediting of Curriculums *J. B. Davidson, R. A. Seaton*

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

PURPOSE of this message, appearing in state and national farm papers, is to "sell" farmers on the better practices being developed by agricultural engineers and other farm scientists. It is one of many Case advertisements urging the adoption of advanced methods and emphasizing how easy it is to apply them with Case equipment. Samples or supplies of literature mentioned will gladly be sent at your request. J. I. Case Co., Racine, Wis.

★

CASE

Uphill Farming

Goes on the Level

MOST amazing about new ways in farming is that they are not more difficult, but actually much easier. Contour tillage, for example, does more than save precious topsoil. It also does away with hill-climbing and gear-shifting, enables tractors to pull bigger loads at steady speed, gets work done in less time and saves gallons of fuel. That's because every job from plowing to harvest is put literally on the level.

Other developments are showing the way to better, easier farming, too. Modern methods of handling manure, fertilizing fields, providing lush pastures and putting up protein-rich hay, all help to lift farm earnings to higher levels instead of being an uphill battle. The gains come both from bigger production and from easier, faster, less costly work.

There's a reason why Case machines being built now . . . or even old ones . . . are ready for the newer, easier, more productive practices. They are built with vision born of long years behind them . . . vision that fits them for the methods of long years ahead. They are built with the Case quality of ENDURANCE . . . the ability to give long years of good work with little expense for upkeep.

You can preserve your precious soil fertility, enjoy greater earnings and easier farming by adopting as many of these modern developments as fit your farm. Your Case dealer can help you in the use of present machines and in the choice of new. J. I. Case Co., Racine, Wis.

CASE ★ ★ ★

Send today for this new free bulletin. See how easy it is to use the time-saving, soil-saving, crop-boosting practices on your farm. Other free bulletins on building broad-base terraces with your own one-way disk or moldboard plow (say which you use), on how to put up high-protein hay, and on double returns from manure.

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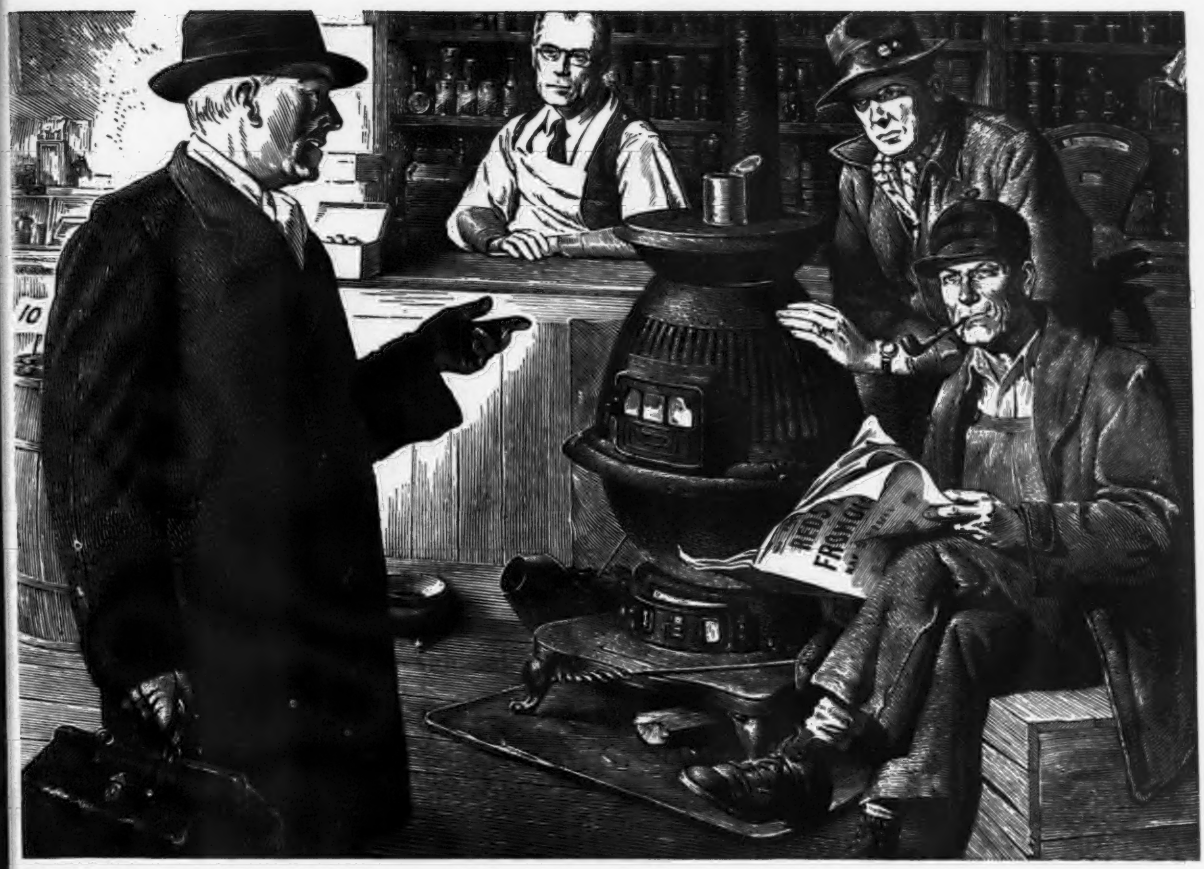


"Boys, I'll tell you what Free Enterprise really is!"

It's a lot of little things—and some mighty big things, too.

But in a nutshell, it's our right to live our own lives, run our own farms and our own businesses in our own way—without needless interference.

It's our right to criticize the government, bawl out the umpire, belong to the Grange, or make a speech on the public square. It's our right to travel when and where we choose—to work or not, as we please.

It offers *opportunity* to anyone who really wants it. It rewards thrift, hard work and ingenuity. It thrives on competition and raises our standard of living. It encourages invention, stimulates research and promotes progress.

It offers us a chance to save and invest and build and grow.

Under Free Enterprise men who have faith in an idea can take risks to develop it. Our railways started that way. So did the motor car industry—and oil and steel and aviation and scientific mechanized farming.

Free Enterprise made small farms and factories into big ones—and then started more small ones. And now, fighting a desperate war in which production will turn the scale, America is out-producing every other country in the world, hands down—and is doing it faster and better.

Yet in spite of all this, some folks would like to change our American way of doing things—and rebuild our whole country under a *new* and *different* system.

If they had their way, Tom here, wouldn't own this store. He'd be regimented with a lot of other storekeepers and told how to run his business by some bureaucrat who probably never tended store in his life.

Ed's farm would belong to the state, and Ed would be told how to run it and what to raise by someone he wouldn't even know.

Jim would be working for a state-owned factory—with his job and wages frozen. And I don't know *where* we country doctors would be.

We fellows aren't rich—and probably never will be. But we've got a lot of self-respect and religion and decency and common sense. We own our own homes and farms, send our kids to college, have cars, radios, and a lot more of the luxuries of life than millions of people living under fancy political systems and "planned economies" in other countries.

Sure, we're willing to put up with a lot of irritating things right now—in order to win the war—but I don't believe we'll stand for being pushed around much after it's over.

Frankly, I don't like the name Free Enterprise for the system under which this country has grown great. I'd rather call it *American* Enterprise, because it's the most American thing we have. It really *is* America. Let's *keep* it.

BUY WAR BONDS AND STAMPS —AND KEEP THEM!

The Army-Navy E flag waves over 7 Republic plants and the MaritimeM floats over the Cleveland District plant.

REPUBLIC STEEL

GENERAL OFFICES: CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, New York

WOVEN WIRE FENCING • BARBED WIRE • STEEL FENCE POSTS • BALE TIES
ROOFING and SIDING • NAILS • STAPLES • BOLTS, NUTS and RIVETS • PIPE
CARBON, ALLOY and STAINLESS STEELS for FARM and DAIRY EQUIPMENT

You can't feed America ....BY HAND

ONLY with Modern Production Machinery can farmers feed our fighting men, and the folks at home.

The most modern of all farm machinery is the FOX Pick-up Hay and Forage Harvester with its Pick-up, Mower Bar and Corn Harvesting Units. This machine is to the farmer what the production line is to the manufacturer.

☆ ☆ ☆

The FOX is built by the Pioneers of Modern Forage Harvesting. Write us; we will be glad to tell you all about this marvelous machine.

R. C. Krueger
Secretary

FOX

The FOX Hay and Forage Harvester

—will pick up, chop and load, ready for the mow or stack, 2 tons of dry hay in 12 minutes.

—will mow, chop and load, in one operation, over 200 tons of grass silage a day.

—will cut corn of any height, chop it into silage, load it into wagons ready for the silo, all in one operation.

FOX RIVER TRACTOR COMPANY
1824 N. RANKIN ST.
APPLETON FOX WISCONSIN

Pioneers of Modern Forage Harvesting

SHOCK!
STEEL
STEEL
METAL-TO-METAL contacts cause SHOCK . . VIBRATION . . NOISE . . WEAR . . DESTRUCTION!
RUBBER
RUBBER
RUBBER-TO-RUBBER contacts ABSORB shock . . . MINIMIZE vibration . . . MUFFLE noise . . . PROLONG LIFE of moving parts!
Cut-away view of threshing mechanism in a modern combine. Rubber faced steel cylinder bars, operating in connection with a rubber stripping plate, and two stationary block rubber concaves, protect hard and soft shell crops from damage.

SHOCK is the foe of machinery. SHOCK and resultant VIBRATION caused by metal-to-metal contacts of moving parts are fast being eliminated by modern processes of rubber-to-metal adhesion.

A "striking example" of metal-to-metal *versus* rubber-to-rubber contacts is the development of the modern combine or "all-crop harvester."

ORCO engineers, working closely with farm machinery engineers, applied modern rubber adhesion processes to eliminate metal-to-metal contacts in threshing mechanisms.

The "end result" was elimination of SHOCK which in old style harvesters limited the machines to hard shell crops and often caused damage to both crops and machines.

Rubber-to-rubber contacts now widen the scope of the modern combine to include soft shell as well as hard shell crops. Machines last longer. Crops are protected against crushing. Operators are relieved of fatigue caused by excessive noise and vibration.

When YOU encounter problems involving SHOCK and VIBRATION in moving parts of machinery, ORCO engineers are prepared to co-operate. Ask for ORCO-OPERATION!

"ORCO-OPERATION"

THE OHIO RUBBER COMPANY · WILLOUGHBY, OHIO

BRANCHES: DETROIT · NEW YORK · CHICAGO · INDIANAPOLIS · WASHINGTON · CLEVELAND

Put electricity to work...increasing production and profits on your farm!

Farmers all over America are discovering new ways to put electricity to work—*producing more and better farm products.*

Read what progressive farmers have to say about how electricity has helped them step up production—save time and labor—increase farm profits.

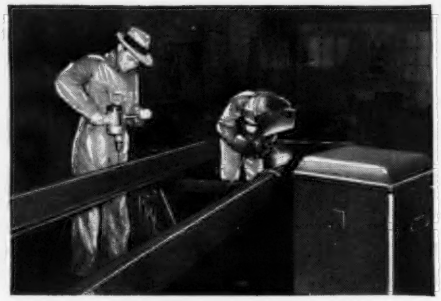
For practical information on getting the most out of electricity on *your farm,* send for the Westinghouse Farm Bulletins listed in the coupon below!

"MY ELECTRIC MILK COOLER cuts my cooling costs in half. In three years, my Milk Cooler Unit has paid for itself. My milk is never rejected and I always get top prices for it. *I couldn't stay in business without my Electric Milk Cooler."* . . . Ralph Elwell, Bernardston, Mass.

"SINCE WE INSTALLED DRINKING FOUNTAINS, our average annual butter fat production jumped from 430 to 475 pounds per cow—*a profit increase of about $375 per year.* Here's proof that an electric water system can be made to *pay for itself in a year*—and leave a handsome bonus besides!" . . . Clyde Schneeman, Pontiac, Ill.

"MY ELECTRICALLY DRIVEN haydrier takes about all the weather hazards out of haymaking. I field-dry the hay 5 hours—then put it right into the mow and turn on the electric blower. In about two weeks my hay is *perfectly cured.* This haydrier *paid for itself the first season."* . . . R. C. Williams, Wytheville, Va.

48 MINUTES SAVED FOR A PENNY . . . "It used to take me 60 minutes to scoop out the wagon and throw the corn into the crib. Now, with this ear corn elevator, I can store 100 bushels of corn in 12 minutes, saving 48 minutes of my time—*for a penny's worth of electricity."* . . . Ed H. Forest, Wauseon, Ohio.



"OUR FARM WORKSHOP keeps the farm machinery in good working order so that the tools *are always ready* whenever there is work to be done in the fields. In the slack season, we save hundreds of dollars a year by *reconditioning* and *rebuilding* our farm tools and equipment." . . . K. T. Hutchinson, Murfreesboro, Tenn.

DURING THE PAST YEAR— Westinghouse has been offering Special Farm Bulletins to show *how electricity makes money for the farmer.* If you have missed any of these Bulletins, check the ones you want on the coupon and mail it, *today!*

Whenever you see the WESTINGHOUSE nameplate on electric farm motors, farm equipment and household appliances, you can always be sure of sturdy construction, economical operation—long, trouble-free life. *Westinghouse is the name that means everything in electricity.*

Westinghouse

Plants in 25 Cities ○ *Offices Everywhere*

WESTINGHOUSE PRESENTS John Charles Thomas, *Sunday, 2:30 EWT, NBC.*
Ted Malone, *Monday, Wednesday, Friday, 10:15 pm, EWT, Blue Network.*

Westinghouse Electric & Mfg. Co. (Dept. AE-124)
Rural Electrification, 306 Fourth Avenue, Box 1017
Pittsburgh 30, Pennsylvania

Please send *free* Farm Bulletins checked below–

☐ Practical Facts about Milk Cooling ☐ Ear Corn Elevator
☐ Farm Garden Watering Guide ☐ Home Canning Guide
☐ Construction of Haydrier ☐ Dairy Cattle ☐ Power Slicer
☐ Community Canning Center ☐ Modern Farm Workshop

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Address.....

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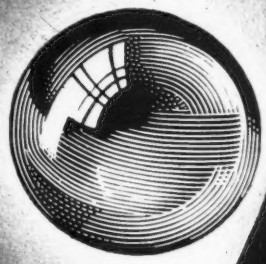
But how do they make 'em so ROUND?



While the steel ball is but one little part of a ball bearing, it's a most important part—and making it "round" is a most important and interesting process.

The extreme precision limits obtained (such as diameter within *two one-hundred-thousandths of an inch*) and interesting facts regarding the wonderful strength of the steel ball, are among the subjects covered in our little Booklet "BM".

We will be delighted to send you one for the asking.

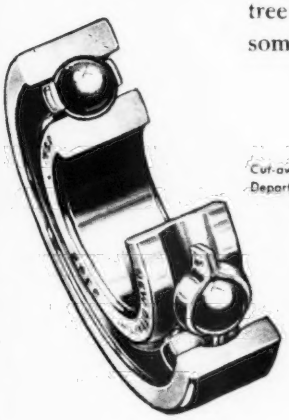
Meanwhile, remember that every mechanical device that helps make our civilization possible, has ball bearings in its family tree—somewhere—somehow!

1 Slug of steel wire is placed between accurately formed dies.

2 Under heavy pressure, dies forge slug into a rough ball with minimum of "flash".

3 & 4 Grinding to perfection of diameter and sphericity is done in very much the same way that human hands can roll a ball from a lump of putty.

5 Final grinding and lapping polishes sphere to a brilliant finish—not for "looks", but for *perfection* of form and size.



Cut-away view of New Departure Ball Bearing

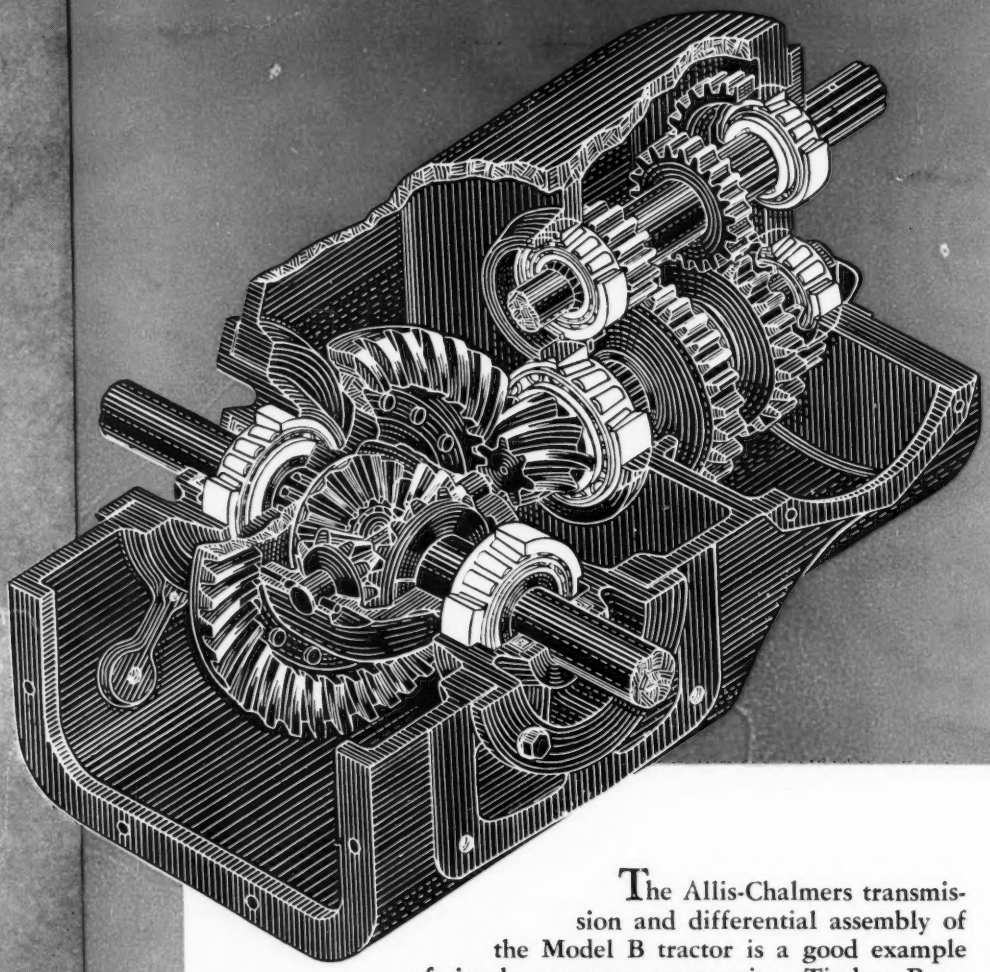
nothing rolls like a ball

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE · DIVISION OF GENERAL MOTORS · BRISTOL, CONNECTICUT

Sales Branches: DETROIT, G. M. Bldg., *Trinity 2-4700*
CHICAGO, 230 N. Michigan Avenue, *State 5454* LOS ANGELES, 5035 Gifford Avenue, *Kimball 7161*

A GOOD EXAMPLE OF *Compact Design*



The Allis-Chalmers transmission and differential assembly of the Model B tractor is a good example of simple, compact construction. Timken Bearings lend themselves particularly well to designs of this kind. The pinion and ring gear are always subject to radial and thrust loads. In low gear these may be unusually heavy. Accurate and precise adjustment of tooth contact is therefore essential. The ring gear and differential unit, which is cup adjusted, may be set to the proper contact with the pinion by interposing shims between the cup carriers and the transmission case.

The pinion, which is integral with the shaft, is matched with the ring gear to provide proper tooth contact. The bearings on this shaft are indirectly mounted to handle the heavy radial and thrust loads which are imposed on the bearing adjacent to the pinion and to maintain the rigidity of the shaft. The countershaft bearings are directly mounted and adjusted by means of shims inserted between the outside of the transmission case and the cup follower. Equipment designers are invited to avail themselves of the wide experience of the Timken Engineering Department in solving bearing application problems. No obligation, of course—

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN

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TAPERED ROLLER BEARINGS